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No. 44

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This serial report contains information on economic aspects of the fuels and power industries including management, production, distribution, consumption, and related equipment; measures to overcome shortages such as conservation campaigns and development of alternative sources of energy.

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CONTENTS

 [III - USSR - 37]

ELECTRIC POWER

ELECTRIC POWER STATIONS AWAITING FUEL IN VAIN

Moscow TRUD in Russian 4 Nov 80 p 2

[Article by the Editorial Board of GUDOK—Collective correspondent for TRUD: "Why Are the Cars Standing Idle?"]

> [Text] Dozens of the country's electric power stations are waiting for Ekibastuz coal, however, many obstacles are cropping up in its path.

In Ekibastuz everything reminds one of coal: the names of enterprises, stations and streets; the appearance of the squares and public gardens. A stone tulips, within the petals of which is a piece of coal, has become the distinctive emblem of the city.

One quarter of the fuel consumed by the country's electric power stations is Ekibastuz coal. Its mining (and it is open-pit mining) grows constantly. Last year the yield was 55 million tons, and this year it will exceed 70 (million). In the near future, as Comrade L.I. Brezhnev has emphasized while appearing at a recent convocation of the Central Committee of the Communist Party of Kazakhstan, the task consists of increasing the coal yield in this region to 170 million tons.

Transportation of the coal is realized by so-called circular routes. These are formed from special gondolas which must obligatorily be returned to the consigner after unloading, and thus the closed cycle, the ring, is established.

The advantages of such a method of coal transportation have also been demonstrated by practice in other basins, the L'vovsko-Volynskiy, for example, and, under the conditions in Ekibastuz, this technology turned out to be singularly suitable. The entire coal flow here passes through a single station which is in no condition to "deal with it" if coal is moved using ordinary trains instead of specialized ones. They would simply clog the station completely. On the average 3.7 hours are required for processing each ordinary freight train here, whereas it only takes 0.9 hours in all for a train made up of the specialized gondolas.

Now 80 percent of the coal from Ekibastuz is transported according to progressive technology. However, its realization is associated with many difficulties. It is known that there are not enough cars in the country, and certain rail lines, having

received Ekibastuz trains, do not use them according to their designation, do not return them on time and sometimes even break them up. This causes great difficulties for the Ekibastuz coal workers. This occurs particularly frequently on the Alma-Ata mainline, within its Karagandinskoye division.

An agreement for labor collaboration of related industries was signed in Ekibastuz in August of this year to accelerate delivery of fuel to electric power stations, reduce the time for loading, transportation and unloading, and to strengthen the interaction of railroad workers, coal workers and power workers. Including themselves in an all-around competition, each side adopted concrete socialist commitments: to reduce car idle time during loading and unloading, to raise the speed of the trains and to insure their return to Ekibastuz.

Since that time, the situation has improved noticeably. Workers of the Sverdlovsk, South Ural and Western Siberia railroads have changed their relationship to the "revolving doors" for coal, they are trying to get the specialized empty cars back to the Ekibastuz junction on time. They are searching for efficient variations to deliver fuel to the electric power stations, and are reexamining earlier compiled schedules. And this is the result. Dispatching of coal has grown by more than 140 cars per day as compared with last year.

Nevertheless, winter fuel reserves have not been established at the electric power stations, particularly at such GRES as Serovskaya, Nizhnetagil'skaya and Kargandinskaya. What is the reason for this?

Let us go along the chain linking the coal reserves with the fuel stores. The association "Ekibastuzugol'" should unload up to 3,000 cars daily, but even here, at the very start of the path, breakdowns are observed: the open pit mines do not always get the necessary number of empty cars. Some cars are delayed enroute, others are still being unloaded (beyond any norms) at the electric power stations. In order to understand why this occurs, let us proceed along with a train, for example, to the Sputnik station near Pavlodar. Here the train is transferred to a branch line laid to the Yermakovskaya GRES. This branch line has already been in temporary operation for 17 years, and since this is slow, the norms for car turn-around time are extremely loose: 1.42 days for a 30-kilometer section of track. Trains which are loaded and delivered here according to a high-speed schedule stand at Sputnik station awaiting the diesels belonging to "Pavlodartransstroy"'s temporary operations division. They stand there 3-4 hours, and sometimes longer. By even the most modest estimates, more than 1,000 car-hours are wasted here every day. Thus it happens that all of the efforts of the railroad workers who worked out a new variation for train movement on this sector have gone to waste.

Let us set off in the other direction, to Karaganda. It is a similar picture. A railroad by-pass branch line has been laid to TETs-3, reducing the route of the coal three-fold. However, it is not in operation because they built it not for the TETs alone, and a year has gone by to settle a quarrel over who should take this siding onto their balance sheet. The important fact is that at all of the electric power stations of "Karagandaenergo" [Karaganda Regional Administration of the Power Industry] operating on Ekibastuz coal, the car idle time is great. At GRES-2 unloading lasts 2 1/2 hours longer than authorized. The situation at GRES-1 and TETs-3 are not much better.

"If they would make us conveyors to deliver fuel to the warehouse," say the workers, "give us an additional car dumper, then matters would be speeded up."

Car idle time is also a result of an irregular arrival of trains--sometimes during 2 or 3 days not a single one, and then several at once. The coal workers, rejecting pretensions, nod toward the railroad workers; they say they don't provide cars. But on the other hand, they themselves place them (railroad workers) in a most difficult position, presenting up to 10 trains at once for transfer from their sidings, and that gives you the above-norm idle times! According to the situation in effect here, responsibility for idle time is removed from the coal workers 30 minutes after trains are presented for transfer, regardless of their number. This type of situation in no way stimulates reduction of rolling stock idle time.

In a word, there are still many unresolved questions, and the pulse on the circular coal routes is beating irregularly. However, one cannot notice that territorial trade union elements might be helping the coal workers, railroad workers and power workers to overcome the difficulties which are cropping up and to organize a competition properly. Nor is it felt that effective control over satisfaction of socialist obligations made when concluding the labor collaboration agreement has been set up on the part of the industrial trade unions.

9194
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PROBLEMS WITH DETERIORATION IN GENERATORS

Moscow MOSKOVSKAYA PRAVDA in Russian 28 Sep 80 p 2

[Article by O. Gorbovskaya, Novosti Press Agency: "Why Does a Generator Age?"]

[Text] An original method for restoring generators has been worked out at the All-Union Scientific Research and Planning and Technological Institute of Electric Insulating Materials and Foil-Covered Dielectrics (VNIIEIM).

The average service life of a generator is 15-20 years. Generator breakdown is an extreme occurrence, not only for the electric power station, but sometimes for all of the power system as well. And it is the insulation materials which break down most frequently.

There was only one way to return a generator to life until most recently: the old shafts with insulation which had served its time were replaced with new ones. This was a costly, labor-intensive method requiring replacement of scarce materials--micas, fiberglass fabrics and copper.

Why does insulation age? The scientists at the institute determined as follows: there occurs a partial destruction of a binding link in the system "casing insulation--current conducting part." Bitumen is this binding link. Air cavities form upon its destruction. Electrical discharges form within them under the effect of the electric field, and it is they that destroy the insulation. Research showed that the copper in the current-carrying part of the generator is not destroyed, nor is mica, which is the insulating material.

It is the bitumen that breaks down and which must be removed without destroying the integrity of the remaining generator parts, and replaced with new. But, how can old bitumen be replaced if all the elements on the shaft are impregnated with it? They are firmly soldered together, they have become a monolithic unit. This is what Ye. Yaroshenya, head of research, says about the new method.

"The principles for restoring old insulation which were developed at our institute permit us to remove the adhesive composition which has served its time (the bitumen) using a thermovacuum method. The generator shafts are placed in a special thermovacuum oven, they are heated to the temperature at which the bitumen vaporizes and

it is removed from the oven in this form. After this operation, the shaft is impregnated with the new compound."

The first generator which received new life because of the new method was put in operation at the Volga GES in November 1979. This made it possible to save 16 tons of copper and 5 tons of mica materials. With regard to money the economic savings are expressed in the sum of R400,000.

Now many dozen hydraulic generators from various GES which have served their time are waiting in line.

9194
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AN ELECTRIC HEAT ACCUMULATOR

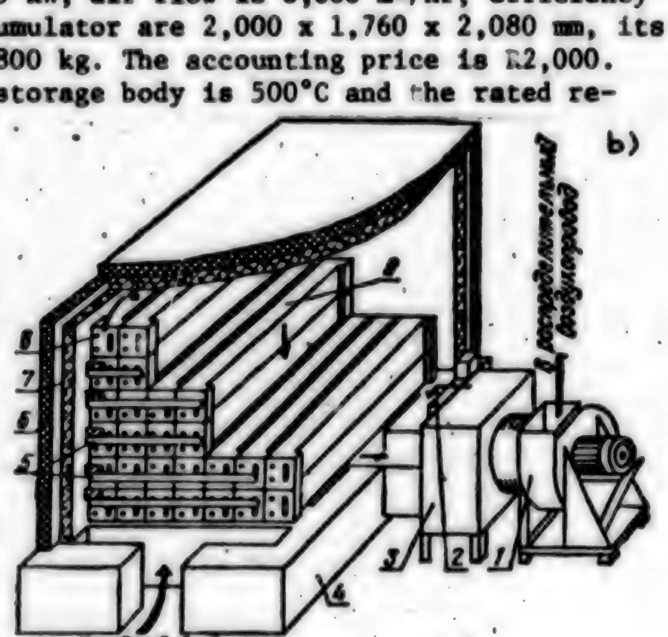
Moscow TEKHNIKA V SEL'SKOM KHOZYAYSTVE in Russian No 10, Oct 80 pp 39-40

[Article by I.I. Shateykis and P.T. Simutis, candidates of technical sciences; A.A. Adomaytis, engineer, Lithuanian NIIMESKh [Scientific Research Institute for Mechanization and Electrification of Agriculture]

[Text] It is expedient to employ electric heat accumulators with a solid storage body in air heating and ventilation systems for pig sties and calf pens. They are easily regulated automatically, they do not freeze and they require little metal.

An electric unit with a block heat accumulator has been developed at our institute. The blocks, with dimensions of 1,200 x 250 x 225 mm, are produced from crushed red brick and portland cement (composition of the concrete is based on Construction Standard SN156-67). A spiral of nickle-chromium wire 1 mm in diameter is placed in special openings in the blocks. The block is rated at 2.38 kW.

An experimental block electric heat accumulator has been in operation since 1978 on the "Vaynutas" sovkhoz, Shilutskiy Rayon, Lithuanian SSR (Cf. Figure). It is used to warm air flow for a pig sty for 230 castrated pigs and pigs and farrow, and it has automatic control. The rated output is 100 kW, the heat flow in the storage mode is 33 kW, and in semi-storage mode, 75 kW; air flow is 8,000 m^3/hr; efficiency is 95 percent. Dimensions of the heat accumulator are 2,000 x 1,760 x 2,080 mm, its weight is 6,500 kg, that of the blocks, 4,800 kg. The accounting price is R2,000. Maximum operating temperature of the heat storage body is 500°C and the rated residual temperature is 100°C.



Electric Heat Accumulator: 1)Ts4-70 No6, 3 centrifugal fan; 2) air distribution vent; 3) air mixing chamber; 4) base; 5) current-conducting bus bars; 6) mineral-impregnated cotton slab [Rus.--mineral-ovatnaya plita]; 7) Haydite concrete slab; 8) heating coil; 9) heat-storage unit; a) cold air; b) to distributing air duct

Sixty hours are required to install this type of unit. The accumulator charge level depends on the temperature of the outside air and the actual residual temperature of the heat storing body. It may be charged in constant storage mode (at night when the schedule for load on the electric system drops off), as well as in a semi-storage mode, when the unit is disconnected from the power system during periods of maximum load.

The supply of air, heated to 200°C, is regulated as a function of temperature in the chamber being heated. To this end, a two-section air vent with electric servomechanism controlled by a three-position heat regulator is specified. When the temperature rises in the chamber, it reduces the air flow from the heat accumulator and increases the influx of cold air. Moreover, there are regulators for maximum (+30°C) and minimum (+10°C) temperatures of air being fed into the chamber.

The heat accumulator is installed in a special ventilation chamber.

Testing showed that the automatic regulation system maintains a temperature within the chamber with an accuracy of $\pm$ 1°C. Recirculation of the air was employed at relatively low outside temperatures.

The heat liberating area of the storage body is $32m^2$.

The unit's thermal insulation housing consists of Haydite concrete slabs 70mm thick covered with a mineral-impregnated cotton slab 100mm thick. The temperature of the outer surface of the housing exceeds the air temperature in the ventilation chamber by not more than 20°C.

The heated air is distributed through two perforated ducts 250 x 250mm in cross-section. Pressure loss in the heat accumulator is 225 Pa.

Tests on the unit showed the promise of heating-ventilation means of this type for establishing a microclimate in animal husbandry facilities. The annual economic savings from employing the unit is about R1,400 as compared with heating from an ordinary boiler room with the KV-300 boilers.

9194
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MEASURES TO BRING ABOUT FUEL, ENERGY SAVINGS

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE in Russian No 9, Sep 80, pp 68-70

[Article by I. Stepura, TsNIITEI sector chief, and N. Kovalev, deputy division chief: "In All Units of the Electric-Power Engineering Network"]

[Text] The current five-year plan provides for a reduction in the norms of boiler-furnace fuel outlays by 3--4 percent, and in those of electric and heat energy by 5 percent. A reduction is proposed in the proportional fuel outlay per kilowatt-hour of electric power from 340 grams in 1975 to 325 grams in 1980. However, there are considerable reserves for overfulfilling the plan with regard to fuel economies. A more rational utilization of all types of energy resources and a reduction of energy losses in electric-power transmission lines and heat networks will help to conserve hundreds of millions of tons of conventional fuel throughout the country.

The importance of all possible measures with regard to saving fuel and energy is growing in connection with the fact that the fuel shortage is increasing sharply, particularly in the European part of the USSR. We must seek out not only new technologies and sources of energy but also devote our attention to those trends in technical progress which will allow us to achieve considerable savings in mineral raw materials and fuel. In all units of the electric-power network it is feasible to provide for the implementation of organizational, technical, and economic measures.

During recent years a trend has been noted in the direction of a growth in the proportional outlay of energy resources per unit of output in connection with the rise in the technical level of production, the change in the quality of energy resources, the growth of speeds in transport, and other factors. Thus, as early as 1975 the proportional fuel outlays increased with respect to 11 out of 46 types of output, while those of heat and electric power increased with regard to 18 out of 71 and 61 out of 105 respectively.

A considerable portion of the energy-using equipment pool (compressors, electrolyzers, electric motors, etc.) and technological processes have become obsolete and do not meet the present-day requirements for raising the efficiency level of fuel utilization. For example, there is a need to:

replace about 100,000 small-size boilers whose efficiency is 30--40 percent less than in up-to-date boiler units.

There is insufficient use of the potential for converting electric-power stations to more efficient types of fuel. TES's burn coal, fuel oil, natural gas, peat, and shales. Their conversion from operating on one kind of fuel to another is sometimes carried out. However, this is usually done under specific production situations, for example, when there are departures from the pre-planned structure of the country's fuel-energy balance. For such stations in accordance with their role in the load schedule of an energy system (operation on a basis of semi-peak or peak load zones) one may plan different types of fuel with respect to the seasons and the time of day (in winter--coal, in summer--gas, during peak-load hours--fuel oil, during most of the daytime hours--coal). TES's can be adapted relatively easily and in short periods of time to burn gas or fuel oil instead of coal with modest capital investments but with the achievement of substantial savings in fuel and production outlays.

For example, at the Zhidachevskaya TETs during the summer period the boiler units were converted to burning gas instead of coal. Significant savings were effected because of this. The conversion of TES's from coal to gas during the fall-winter period solves the problem of satisfying the growing need in this period for gas by other more economical consumers.

In the USSR gas is utilized in producing 85 percent of the cast iron, 86 percent of the Martin (open-hearth) steel, 46 percent of the rolled ferrous metals, 75 percent of the synthetic ammonia, and 62 percent of the cement. These results have been achieved by means of replacing coke, fuel oil, and other energy-bearers with gas, and this allows a considerable portion of the fuel oil to be directed to electric-power stations and to industrial boiler units. The national economy achieved a great economic effect, since the replacement of coke by gas in blast-furnace production guarantees a savings of 15--20 rubles for every 1,000 cubic meters of gas.

Unfortunately, such measures are not carried out often in the national economy. Too much gas is utilized as fuel at TES's. With the aid of electric power, despite its universality, only 1/9 of terminal power is produced. The predominant part of it (54 percent) is still produced by means of the direct use of fuel.

The comprehensive utilization of an energy resource as a chemical raw material and as a type of energy is yet another example of interchangeability. Thus, electric-power engineering and chemistry are not only connected as the producer and consumer of large amounts of energy but they also interact and compete among themselves, being consumers of the same raw-material resources (gas, petroleum, shales, coal). We can also determine the rational limits of the interchangeability of energy and materials. For example, there exists a definite interchangeability between the thickness of metal together with the thermal insulation of kilns for roasting cement and the amount of

energy delivered. Metal smelting and other electrothermal processes can be carried out with the aid of electric power at low, standard, or high frequencies.

In our opinion, two basic reasons complicate all the possibilities for representing the interchangeability of energy resources in the national economic plans. These comprise the lack of a classification for all types of interchangeability and the absence of data for a comprehensive evaluation of the efficiency for the national economy of utilising each type of energy resource for this or that targetted purpose. Up to the present time no studies have yet been made of the rational limits of interchangeability and the trends for changing them, nor have we carried out planning for the multi-sector complexes of material production.

In the presently existing practice of planning the variants which are determined for developing the fuel-energy sectors and the structure of the fuel-energy balance are, as a rule, considered to be rational. However, by virtue of the fact that such variants do not reflect all the possibilities for interchangeability which now exist in the national economy, they are still not rational. In order to objectively reflect interchangeability in the long-term five-year plans and the one-year plans and to optimise the fuel-energy balance for the purpose of achieving substantial growth in the efficiency of social production as a whole, it is necessary to organise joint planning of the fuel-energy sectors.

The proportion of solid fuel consumed by electric-power stations is equal to 45 percent, gas--35 percent, and liquid fuel--20 percent. One of the necessary conditions for insuring the accelerated development of electric-power enterprises operating on organic fuel, for creating the most up-to-date electric-power engineering equipment, and for implementing measures on fuel economies, is the development and introduction of new specific methods for the preliminary processing of fuel.

Thus, at all TES's an increase in productivity by 30 percent and a reduction of energy outlay by 20 percent have been achieved by introducing surface-active coatings, thermal improvements, and gasification of solid and liquid fuel, as well as the briquetting of small-grain coal. For high-ash and large-grain solid fuel the following methods are most feasible: high-temperature processing with a conversion of the organic substance into combustible gaseous components, a combination of pyrolysis (decomposition by heat) of the natural fuel in a pulverized state with non-residual pre-gasification of the forming coke. These and other progressive methods are still not being widely used because of the shortage of new equipment.

In the preliminary processing of fuel it is feasible to introduce new specific methods for preparing solid, liquid, and gaseous types of fuel, to develop new methods of milling (pulverization) with the use of additives, thermal improvement, gasification, etc. We also need to organize new electric-power engineering production for the purpose of optimally combining

the energy and raw-material properties of fuel-energy resources, as well as creating an extended network of fuel-storage facilities and classes of capacities for ring-type coal bunkers at large-size TES's.

The new, ring-type bunkers at the large-size TES's, whose equipment and machinery guarantee a continuous feeding of fuel and the mechanized operation of all storage facilities are considerably more economical than the rectangular-type bunkers. The introduction of ring-type bunkers, equipped with pile-stackers (packers,, rotary loaders, and other equipment, instead of crane-type loaders, has allowed the Permskaya GRES in its fuel-storage capacity alone to effect savings of more than 3,000 tons of metal, 9,000 cu. m. of concrete, and to reduce by a factor of 2.5 the number of personnel employed at the storage facility.

Large potentials for fuel economy are concealed in optimizing the regimes of energy consumption. Because of the high degree of unevenness in the load schedules of electric-power systems, they have an over-expenditure of fuel by more than 15--20 percent. Electric-power capacities are under-utilized by 40--50 percent during the nighttime hours, and are overloaded by a corresponding amount during the peak-load hours. In connection with this, there is a need to build high-cost, special peak electric-power stations and to operate large electric-power units in an uneconomical, alternating regime.

In order to adapt the load schedules of consumers to a rational schedule of an electric-power system, the need has arisen to conduct special organizational and technical measures which would allow considerable fuel savings to be achieved. Thus, by improving the production organization we could reduce energy consumption at the enterprises of various sectors during the hours of maximum use of the energy system by 10--20 percent.

In designing units and planning new production capacities, we need to take into consideration the optimum regulation of an enterprise's electric load. Research studies have revealed the possibility of reducing the maximum load of an energy system by 7--9 percent and for increasing it during the nighttime hours by 2--3 percent.

The energy-consuming sectors of industry have widely but still insufficiently introduced measures for utilizing secondary energy resources with a high temperature potential (150°C)--those of blast furnaces, converters, and other units discharging hot gasses, the heat of exhaust gasses and liquids, processed steam, and hot water. Low-temperature secondary energy resources, whose proportion amounts to as much as 45 percent, are hardly used at all in industry because of the fact that they are contained, as a rule, in polluted and aggressive (corrosive) liquids and gasses.

In the oil-refining industry alone low-temperature secondary energy resources comprise up to 85 percent of the energy going into production. For the utilization of high temperature and, in particular, low-temperature secondary

energy resources, the arsenal of technical means for ensuring their effective utilization can be considered unsatisfactory. The efficiency (performance rating) of industrial units, as a rule, is equal to 15--45 percent. A considerable portion of the heat escapes in the exhaust with the smoke gases and the water.

The following data testify to the importance of the widespread introduction of measures on utilizing secondary energy resources. In metallurgy their discharge falls within the limits of half of all the fuel expended in this sector, and this amounts to several millions of tons of conventional fuel annually. An analogous situation occurs in non-ferrous metallurgy, in the oil-refining sector, as well as in machine-building and metal-working, and the building-materials industry.

In our opinion, it is necessary to establish energy-efficiency norms (performance ratings and proportional fuel expenditures) for equipment in GOST in order to stop manufacturing units which fail to come up to the present-day level of favorable utilization of fuel and energy; and to introduce a system of economic incentives which would encourage the fullest possible use of secondary energy resources and low-grade solid fuels. It is feasible to supplement the presently existing general plant norms with electrical engineering norms which would take into consideration the expenditure of fuel and energy resources which are part of the production of an energy-consuming product, that is, to put into practice the planning of multiply considered outlays. It is feasible to work out such norms by means of simulating the fuel-energy balances of enterprises.

Thus, the potentials for economizing on fuel and energy are very great in our economy at present. Our task consists of fully utilizing these potentials.

2384
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MAIN TRENDS IN TASHKENT FUEL, ENERGY PLAN DESCRIBED

Tashkent STROITEL'STVO I ARKHITEKTURA UZBEKISTANA in Russian No 9, Sep 80 pp 23-24

[Article by Engineer G. A. Shagas (Uzbek SSR Gosstroy): "Main Directions in the Development of the Tashkent Fuel and Energy Complex"]

[Text] The main directions for the formation of systems of fuel, electricity and cold supply stated in the fuel and energy section of the Tashkent general plan were defined on the basis of results from studies on an increase in the efficient consumption of fuel, capital investments to the development of the fuel and energy complex, as well as scientific and technical developments in perfecting power units. The ecological and socioeconomic factors, specific conditions for the formation and characteristics of the fuel and energy industry, trends in the practice of designing and planning the development of energy systems, possible rates and scales of growth in the consumption of fuel and energy resources were studied and taken into consideration. Comparative technical and economic calculations of developmental versions were made.

The structural components in the Tashkent fuel and energy complex are components of a number of large systems: the electrical-energy OES [united energy system] of Central Asia; the Tashkent-Frunze-Alma-Ata gas supplying BGR [expansion unknown]; the fuel industry; and engineering equipment of populated areas.

By 1975 a system of centralized fuel supply for the residential-civilian development of Tashkent had formed from the TashTETs and the rayon boiler ME [magnetoelectric instrument] and the Uzbek SSR E [expansion unknown] with heat output of 1940 giga-calories/hour with developed network of main heat pipelines (129 km). At the same time the total thermal power of all the boiler units, including the small and industrial, was 3196 giga-calories/hour. The Tashkent plan (1953) stipulated that the city should be gasified in a volume of 850 million m^3. In 1975 1.8 billion m^3 of gas had already been realized, including: 0.781 billion m^3 for industry, 0.18 billion m^3 for the population, and 0.606 billion m^3 for generation of heat and electricity. The percentage of boiler-furnace fuel in the structure of consumed mineral fuel resources was 67%. The percentage of natural gas in the structure of fuel resources consumed to generate heat and electricity reached 93%. The air conditioning units became a major consumer of electricity. Besides autonomous household air conditioners, central cooling stations with cold output of about 90 Gcal of cold per hour are operating in Tashkent.

Thus in 25 years in Tashkent (from 1950 to 1975) a powerful separate energy system was formed with generation of electricity mainly at thermal condensation power plants, heat at water heating and steam boiler houses, and cold at compressor cooling machines that use electricity.

Analysis of the planned developments of the specialized institutes demonstrated that further development of the Tashkent energy system on the separate plan was planned in the future. At the same time the level of consumption of fuel and energy resources reached such dimensions that permit a qualitative transformation of the separate components in the fuel and energy complex into an organically linked complex system.

The calculations that were made showed that the high rates of development of industry, municipal services, residential and civil development with high rates of growth of the urban population govern the further, significant rise in the demand for heat, electricity, cold, and in the final analysis, fuel resources. A comprehensive energy-economic evaluation has been made of the alternative plans of future energy supply for Tashkent:

separate plan (I): generation of electricity on the condensation cycle (Novo-Syrdar'ya KES [condensation power plant]), generation of heat by rayon boiler houses with hot water boilers, production of cold by compression electricity-consuming or absorption heat-consuming cooling machines;

complex combined plan (II): central heating and power plant generating electricity based on heat extractions that cover the loads of heating, ventilation, hot water supply and air conditioning while generating cold by heat-consuming absorption bromine-lithium units.

The important advantage of version II is the significant saving of fuel (up to 28.6%). In addition, according to the calculated relative outlays the version of the complex combined plan of energy supply (II) is more efficient than the separate plan of energy sypply (I) by 16.2% (in limits of the examined systems). The second version also has the advantage in capital investments and operating expenditures. The absolute efficiency of the complex combined plan of energy supply made it possible to recommend the conversion of the formed separate plan into an organically linked complex system of combined thermal, electric and cold supply to residential, civil and industrial developments (without technological heat in the form of steam)to the calculated year according to developmental stages.

Versions were also examined for a balance of power of the Tashkent electricity system for the future. One of the versions considered building a TETs in Tashkent. The optimal version of fuel balance was developed. The introduction of the complex combined plan of energy supply will save about 6.5 million T of conventional fuel per year by the calculated period.

Tables 1 and 2 present the main indicators for the examined versions of energy supply plans.

The formation of a complex combined plan of heat, electricity and cold supply by constructing a central heating and power plant (TETs with heat mainline system) and central heating and cooling plants with heat-consuming cooling units, including a system of heat and cold supply distributing networks is accepted as the general

Table 1.

Indicator	Unit of measurement	Separate plan		Combined plan
		Version I	Version Ia	Version II
Consumption of cold	Gcal/h / thous.Gcal/yr	1515 / 2230	1515 / 2230	1515 / 2230
Consumption of electricity to generate cold	mW / mill.kW-h/yr	510 / 1075	38 / 77	38 / 77
Consumption of heat for generation of cold	Gcal/h / thous.Gcal/yr	-	2160 / 3190	2160 / 3190
Consumption of heat for hot water supply	Gcal/h / thous.Gcal/yr	1640 / 12160	1640 / 12160	1640 / 12160
Consumption of heat for heating and ventilation	Gcal/h / thous.Gcal/yr	8560 / 12900	8560 / 12900	8560 / 12900
Total consumption of heat: from turbine extractions	Gcal/h / thous.Gcal/yr	-	-	5220 / 25450
from boilers	Gcal/h / thous.Gcal/yr	10200 / 25060	10200 / 28250	4980 / 2800
Power of plants	mW	4140	3640	3400
Annual generation of electricity, including:	mill.kW-h	24820	21840	20400
on central heating cycle	mill.kW-h	-	-	15750
on condensation cycle	mill.kW-h	24820	23470	4650
Consumption of conventional fuel for power plant	thous. T con. fuel	7980	7530	8350
Total consumption of conventional fuel	thous. T con. fuel	12360	12480	8820
Total consumption of conventional fuel	%	100	101	71.4

Table 2.

Calculated economic indicators million rubles	Separate plan		Combined plan
	II KES, boilers and KKhM	II,a, KES boilers and ABKhM	II TeTs and ABKhM
A. Capital outlays			
Total,	1155.1	1085.6	1094.0
the same in %	100	93.8	94.0
B. Operating expenditures			
Total	315.45	304.95	248.75
the same in %	100	96.7	78.8
C. Relative outlays			
Total	453.95	435.35	380.05
the same in %	100	96.0	83.8

trend. Taking into account the ecological situation that is governed by specific natural-climate and meteorological conditions, natural gas is adopted as the main type of boiler-furnace fuel. In order to supply it to the Tashkentskaya oblast it is necessary to have a corresponding development of the gas industry in Central Asia and build a new system of gas pipelines from the gas extraction region.

For a further perfection in the scientific and technical level of the complex combined system of energy supply, improvement in the efficient use of fuel and reduction in its consumptions per unit of energy product it is necessary to formulate and realize a target scientific and technical program. The forces of the scientific research, planning-design institutions and industrial workers should be concentrated in it for the maximum use of the scientific and technical achievements in solar energy technology, the technology of generating and consuming cold, as well as the technology of using fuel.

The ecological cycles and power units with deep cooling of the exhaust gases that have been suggested by Doctor of technical sciences, Professor A. N. Lozhkin (VNIIPIenergoprom)* [All-Union Scientific Research and Planning Institute of the Energy Industry]are of special interest. The most important trend is the reconstruction of the extant power sources whose equipment is rapidly becoming obsolete and worn out.

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CSO: 1822

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*Lozhkin, A. N. "Economic Cycles and Power Units with Deep Cooling of Exhaust Gases," Tezisy doklada na uchenom sovete instituta VNIIPIenergoprom ["Summary of Report at Scientific Council of VNIIPIenergoprom"], Moscow, 1979.

ENERGY CONSERVATION

MAR'INA GORKA GORISPOLKOM RESPONSIBLE FOR LAG IN WINTER PREPARATIONS

Minsk SOVETSKAYA BELORUSSIYA in Russian 25 Oct 80 p 2

[Article by V. Bel'skiy: "Mainly?"]

[Text] Mar'ina Gorka is a small city, but it is not so easy to supply it with heat and hot water.

The deputy chairman of the Pukhovichskiy rayispolkom, P. M. Lipskiy, just went to the city boiler house. "Here is our 'painful place'," he explained. "The fact is that since 1974, by permission of the Belorussian SSR Gosplan the boiler house was converted from solid fuel to domestic furnace fuel. A fuel consumption fund was set up then, 1,300 tons per year for the 6 active boilers. But Mar'ina Gorka grew rapidly. After 1974 dozens of residences, a grain elevator, flax plant, bulk plant and mixed feed plant were erected in the city limits. We were therefore forced to expand the city boiler house and install an additional eight boilers, including three for hot water supply. The consumption of furnace fuel correspondingly rose by 1,700 tons. However they refused to register our expanded boiler house, and therefore additional funds were not allocated for it. We are procuring fuel by hook and by crook. We even have to use kerosene to heat the boilers. This year we are somehow still holding out. We got 900 tons of kerosene, but after that we do not know what will happen."

We note that even after the start-up of the additional eight boilers, hot water is supplied to the homes only four times a week, while the temperature in the apartments on frosty days drops to 13 degrees.

In the preparation for winter there are many other "painful places" in the city, although the deputy chairman of the rayispolkom assured us that everything has "mainly" been already done and the planned measures have been "partially" fulfilled. The communal services are not sufficiently concerned. The Mar'ina Gorka section of the trust "Vodokanal" is organizing repair of the water pipes and sewer systems extremely slowly on the Oktyabr'skaya, Kommunal'naya, and Kalinina streets. The Pukhovichskiy kombinat of public utilities still has not completed the preparation of housing for winter, has not started heating the pipelines in the basements of residences nor the entrance doors, and has not checked the shut-off fittings. In the city bath immediate repair of the hot water tank is required, and it is necessary to replace the roof, and renovate the showers and other rooms.

As it turned out, the gorispolkom is poorly informed about the course of winter preparation. Control of the fulfillment of the decisions made by the rayispolkom

on the given question was entrusted to the chairman of the gorispolkom, M. V. Fedorinchik. The deputy chairman, N. N. Surko now says that the kombinat of public utilities is engaged in residential and communal services. They know everything there he says. They may know everything but they are not doing everything necessary.

Such carelessness is unforgivable for the leading workers of the gorispolkom. In order to bring the communal services in Mar'ina Gorka into proper order the common efforts of the citizens are needed: the house committees, enterprises, and public organizations. Therefore the gorispolkom should rapidly take effective measures to complete the preparation of the housing fund and the social-general facilities for winter, and bring the fulfillment of these decisions under strict control.

9035
CSO: 1822

MUSCOVITES EXHORTED TO CONSERVE GAS

Moscow STROITEL'STVO ARKHITEKTURA MOSKVY in Russian No 10, Oct 80 p 36

[Article by the MOSGAZ trust: "Conserve Gas!"--passages enclosed in slantlines printed in boldface]

[Text] Natural gas is the most valuable raw material for the chemical industry. It is used to produce ammonia gas, ethylene, carbon black, sulfur, etc.

Gas is also used very widely as a fuel.

Taking into consideration the significant, ever increasing scales of consumption of natural gas, and the enormous capital investments associated with its extraction and delivery, a concern for its careful use acquires national importance.

Moscow is the largest consumer of natural gas. The continuous supply of the population, communal-general services and industrial enterprises is one of the most important tasks on whose resolution the normal life of the city depends.

A smooth and stable gas supply to the city is impossible without observance of a strict discipline of gas consumption.

Because gas is an important factor in increasing the standard of living and comfort, and possesses technical and economic advantages, it introduces many conveniences into our daily life and is used to produce food and heat water.

There are over 2 million gasified apartments in Moscow. Certain owners have the following attitude towards gas consumption: it is inexpensive, they say, so they leave the gas burners lit.

The economical use of gas for daily needs in such an enormous city as Moscow is a great fuel reserve.

We appeal to all people of Moscow to conserve gas, do not burn it in instruments where there is no need to, do not warm rooms with gas plates. This is not only not very effective, but also dangerous.

Natural gas is our national wealth and truly blue gold.

/An economical attitude to the national property in the duty of each Moscovite./

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CSO: 1822

USE OF PETROLEUM GAS: PROBLEMS, PROSPECTS

Important Economic Reserve

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 10, Oct 80 pp 47-48

[Editorial introduction: "Petroleum Gas and the Economy"]

[Text] Petroleum gas is a valuable raw material of great national economic importance. Liquefied gases, gasoline, and a broad fraction of light hydrocarbons (ethane, propane, butane, and pentanes) are produced from petroleum gas. They are used efficiently as raw material for the petrochemical industry and in the near future ethane will be used in the microbiological industry. A significant advantage of liquefied gases (mixtures of propane and butane) is the possibility of using them as high-octane motor fuel and as domestic fuel in containers. Finally, liquefied gases are a valuable export product with an almost unlimited market.

Because the construction of gas refineries and structures for collecting and transporting by-product gas has lagged significantly behind the rate of growth in petroleum extraction, a large part of this valuable raw material has been burned off in "flares of mismanagement," as they were pointedly christened by journalists. Comrade L. I. Brezhnev, speaking at the November 1978 Plenum of the CPSU Central Committee, stressed: "The question of the struggle against losses should be the subject of business-like, self-critical review. Each specific shortcoming can be explained in terms of its causes. But we must approach this matter from the standpoint of principle, focusing attention on the main thing. And the main thing here is that the central management agencies, the ministries and departments, are going too slowly in converting the entire economy to intensive development. They have not been able to achieve the necessary improvement in qualitative work indicators or to step up scientific-technical progress. This is the root of the difficulties which are holding up more rapid economic development."

Despite the improvement that has been made in recent times, the situation with use of petroleum gas resources in the country is still unsatisfactory. Total losses in the years 1971-1978 were equivalent in terms of combustion heat to 350 tons of ordinary hard coal, and the economic loss runs into billions of rubles. This indicates the scale of the losses as well as the national importance of the problem of fuller and more efficient use of petroleum gas resources.

The articles published below are devoted to the problems of the scientific searching that is underway for solutions to this problem. These articles give a comprehensive estimate of the losses associated with burning off by-product gas and review the organizational-planning, technical and economic factors on which solving the problem of efficient use of petroleum gas depends.

By-Product or Waste

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 10, Oct 80 pp 49-61

[Article by G. A. Terent'yev, candidate of economic sciences, head of the laboratory of technical-economic research on the All-Union Scientific Research and Planning Institute of Gas Refining, Krasnoyarsk: "Petroleum Gas, By-Product or Waste?"]

[Text] A Little Terminology, or What Petroleum Gas Is

The output that comes from the wells is a complex, multicomponent mixture of hydrocarbons and water, a mixture of petroleum, gas, and water. Only on the surface under certain conditions does that part of the light hydrocarbons that has been called petroleum gas separate from the heavier hydrocarbons of which petroleum proper consists. The technological operation which separates the gas and the petroleum is called separation ["separatsiya"]. Thus, petroleum gas is a product removed from petroleum by separation.

Separation is done to separate the gas from the petroleum because gas-saturated petroleum is difficult to transport and the light hydrocarbons will evaporate from the petroleum en route, taking away part of the heavier hydrocarbons with them.

The volume of gas extracted from the earth's interior together with petroleum during exploitation of a petroleum pool for a definite period of time is called the petroleum gas resource. In this case the volume of extracted gas is defined as the product of the gas factor by the amount of petroleum extracted during the calculation period. In turn, the gas factor is the amount of gas per ton of extracted petroleum. The highest gas factor figures occur at the deposits of the Checheno-Ingushskaya ASSR (up to 400 and more cubic meters per ton), the Turkmen SSR (up to 350), and the Ukrainian SSR (up to 300 and more cubic meters per ton). At the petroleum deposits of Tataria, Kuybyshevskaya Oblast, and Bashkiria the gas factor is generally 40-60 cubic meters per ton. The gas factor for the deposits of Western Siberia ranges from 32 to 87 cubic meters per ton.

The 25th Congress of the CPSU set the goal of raising the use of petroleum gas to 43-45 billion cubic meters in 1980, which is three percent of the total volume of mineral fuel resources. Is this a little or a lot?

Relative to all natural gas resources petroleum gas comprises 13 percent (converted to standard fuel). This means that if all petroleum gas is used as energy fuel it could produce 200 billion kilowatt-hours of electricity or 15.4 percent of total national electric power production in 1980. Liquefied

petroleum gas can provide fuel for installed power capacities of 33 million kilowatts, which is 50 percent of the growth plan for the power industry in the current five-year plan by the 25th CPSU Congress.

Growth Trends and Their Contradictions

Petroleum gas refining, despite all the existing shortcomings in its use, developed quite rapidly and by the mid-1960's had in practice become an independent subsector. By this time, gas refineries which planned to refine gas from the petroleum deposits of Tataria, Bashkiria, and Kubyshevskaya Oblast had been launched.

Gas refining has grown especially fast since 1972, at which time the enterprises processing petroleum gas were switched from the management of the Ministry of the Gas Industry to the Ministry of the Petroleum Industry. In the last eight years (1973-1980) gas refining has increased more than 50 percent compared to the preceding 12 years. This is unquestionably good. It is evidence that the subsector for refining petroleum gas within the system of the Ministry of Petroleum Industry has achieved organizational unity.

The fact that the volume of capital investment in the subsector is more than 900 million rubles, which is 50 percent more than the volume of investment in the preceding 15 years from 1961 to 1975, also illustrates the rate of development of gas refining.

Figure 1 below shows the basic technical-economic indicators of development of gas refining.

One does not need to be a skilled analyst to see the growth in quantitative indicators, refining volume, sale of output, and fixed capital, and the decrease in such a key quality indicator as profit.

The indicator of profitability reflects changes in profit and the value of productive capital clearly. The average annual profitability indicators in recent five-year plans have been as follows: 24.4 percent in 1961-1965; 25 percent in 1966-1970; 15.6 percent in 1971-1975.

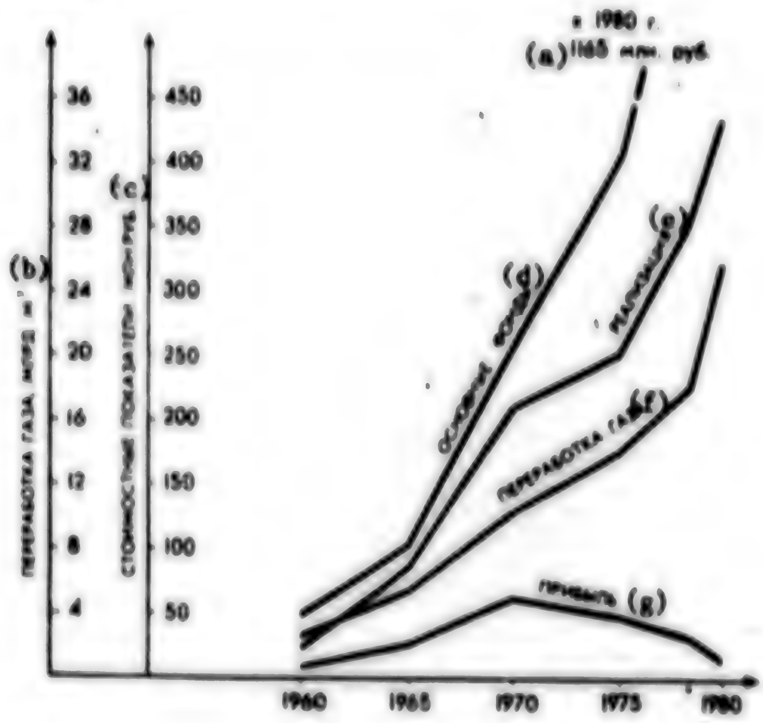
The lowering of gas refining technical-economic indicators is occurring under the influence of subjective and objective factors.

Among the subjective factors we should include errors in planning and design which find expression in delayed introduction of gas refining capacities after the peak of extraction at the deposit has already passed, so enterprises are underloaded; mistakes in selection of a production scheme that does not permit receiving the full volume of raw material or achieving projected indicators for production of output; delays in periods for construction and incorporation of enterprises beyond standards, and others.

Among the objective factors we may include the following:

a. specific features of the operation of gas refineries;

Figure 1. Basic Technical-Economic Indicators of Petroleum Gas Refining.



Key: (a) By 1980, 1,165 Million Rubles;
(b) Gas Refining, billions of cubic meters;
(c) Value Indicators, millions of rubles;
(d) Fixed Capital;
(e) Sales;
(f) Gas Refining;
(g) Profit.

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b. changes in the economic geographical location of gas refineries;

c. the imperfection of the existing price formation system.

Price formation is an important factor in improving the economic mechanism. It is generally accepted in the theory of price formation under socialism that the price should reflect socially necessary inputs of labor (or approximate them as much as possible). In the opinion of the State Committee for Prices, the boundary line of socially necessary inputs should be considered sectorial production costs with due regard for the capital-output ratio and a standard of profitability relative to productive capital at a level of 0.1.[1]

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[1] "Teoreticheskiye Problemy Tsenoobrazovaniya v Usloviyakh Razvitogo Sotsializma" [Theoretical Problems of Price Formation under Conditions of Developed Socialism], Moscow, Preyskurantizdat, 1977, p 13.

At the present time gas refineries are using prices that were developed 11 years ago and do not take account of the changes that have occurred in the formation of socially necessary inputs in gas refining during this time (see table).

Year	Current Costs, rubles	Capital-Output Ratio, rubles	Average Sale Price, rubles	Profit, rubles	Profitability as % of Capital	Profitability as % of Prime Cost
1970	14.13	21.70	19.66	5.53	38.0	25.5
1975	16.52	33.54	19.82	3.30	20.0	10.6
1980 (Plan)	18.8	50.6	20.52	1.77	3.5	9.5

Changes in the economic geographic location of gas refining are not fully reflected in the price-formation factors.

During the period under consideration significant shifts in the location of gas refineries have occurred to the northern and eastern parts of the country, to the Komi ASSR, Western Siberia, and Kazakhstan. The higher capital and operating costs associated with construction and operation of gas refineries in these inaccessible regions with harsh natural and climatic conditions (higher coefficients for construction and installation work, high cost of delivering equipment and materials, higher wage coefficients, and the like) are not compensated for by existing prices on the output of the gas refineries.

These discrepancies and contradictions between the necessity of using petroleum gas rapidly and reducing gas losses, on the one hand, and existing prices on the other, reach the point where the most profitable thing to do is to burn off the gas.

With the prices for petroleum gas and products of its refining operative under the present price list the projected payback period for gas refineries in Tyumenskaya Oblast is 50 years. Under these conditions it is practically impossible to demonstrate the efficiency of even optimal design concepts. Under the conditions that have developed increasing the volume of gas refining in the northern and eastern regions will worsen the technical-economic indicators of gas refinery activity for the Ministry of Petroleum Industry and the All-Union Production Association Soyuzneftegazpererabotka [possibly USSR Petroleum Gas Refining Association].

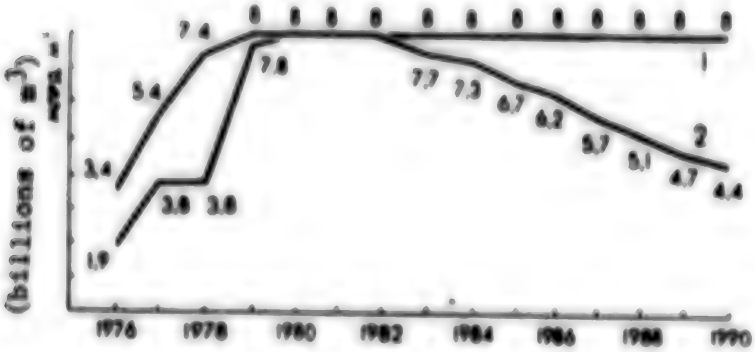
According to our estimate, the decline in the efficiency of production in the gas refining subsector caused simply by changes in economic geographic locations will, given existing prices, lead to a rise in prime cost and drop in profit for the subsector of 51.8 million rubles in 1980 compared to 1975.

If the present situation continues beyond 1980 the situation can only get worse. This is, in our opinion, the main contradiction, the conflict between the necessity of reducing losses of petroleum gas and increasing its refining, on the one hand, and the existing price system, on the other.

The Ministry of Petroleum Industry, to escape from the situation, adopted a temporary decision to reduce the price for petroleum gas delivered by Glavtyumenneftegaz [Main Tyumen' Production Administration for Petroleum and Gas Extraction] to gas refineries from 11 rubles per thousand cubic meters to three rubles, thus transferring the losses to the petroleum extraction enterprises. This forced half-measure makes it possible to avoid the situation for a certain time, but it does not solve the problem of improving price formation for the product of refining petroleum gas, either in the region of Western Siberia or for the entire sector.

The problem of use of petroleum gas and correct, economically sound development of gas refining is most acute in the country's principal oil region, Western Siberia.

Figure 2. Loading of New West Siberian Gas Refineries.



Key: (1) Raw Material Requirement for Total Projected Capacity;
(2) Possible Gas Delivery to Refineries.

Prospects for Development of Gas Refining in Western Siberia

Western Siberia has the largest petroleum gas resources in the country. Intensive development of refining there raises a number of technical, economic, and organizational questions. They are all to one degree or another linked to the economic geographic characteristics of the region, its natural and climatic conditions, and the specific features of extracting, collecting, and transporting petroleum and gas.

Because of difficulties with laying transportation lines for collecting petroleum and gas and their high cost in swampy terrain the industrial facilities of oil field construction are typically centralized. With large and very large deposits this creates the prerequisites for centralizing gas refining capacities. Suffice it to say that the average capacity of gas refineries in operation and under construction in Western Siberia in the current five-year plan is 2.2-2.4 billion cubic meters as compared to the average of 800 million cubic meters in the country in 1975. The Nizhnevartovsk gas refining complex has no equal; it is the largest enterprise of its type in the country and one of the largest in the world.

The relative decrease in capital investment achieved by concentrating gas refining capacities is 25 percent and the decrease in operating costs is 10-15 percent. Prerequisites are created for broad introduction of the latest equipment and progressive gas refining technology. Thus, the capacity of the centrifugal compressor units used at Western Siberian refineries is 4-6 times greater than the capacity of the compressors used at existing refineries in the European part of the country, and in the near future it will increase even more. This makes it possible to reduce the volume of buildings, the total built-up area, and the number of service personnel.

But these and other elements of technical progress cannot compensate for the impact of the harsh natural and climatic conditions, the vast territory, and the underdevelopment of communications lines and other facets of the infrastructure. As a result of these factors capital investment for construction of a gas refinery in Western Siberia is 1.7-2.0 times greater than for similar enterprises in the European part of the country and operating costs are 1.25-1.5 times higher.

The gas refineries of Western Siberia are basically planned to produce two products: dry stripped gas (for municipal and domestic uses) and a broad fraction of light hydrocarbons (ShFLU).

The dry gas is used for fuel at the Surgutskaya GRES and in small quantities for local needs: to supply industrial and municipal-domestic consumers in the Kuznets Basin, to which gas is delivered along the Parabel — Kuznets Basin pipeline; for delivery to the European part of the country by connecting to the Urengoy — Chelyabinsk gas pipeline.

The ShFLU should be used as raw material for the central gas fractionating installations at the Tobol'sk Petrochemical Combine and be delivered there by the Yuzhnyy Balyk — Tobol'sk pipeline. Delay in introducing capacities at the Tobol'sk Petrochemical Combine is causing great losses of ShFLU and making it necessary to transport it outside the region for subsequent processing at refineries in the European part of the country.

While discussing prospects for the development of the gas refining industry of Western Siberia it is advisable to dwell on comprehensive use of petroleum gas. The dry stripped gas from Western Siberian refineries contain significant resources of ethane, a valuable raw material for obtaining ethylene, which is one of the most important polymers for petrochemical synthesis. Even when 70 percent of the ethane is extracted it is possible to obtain about 1 million tons of it a year. Ethylene production with pyrolysis of 1 million tons of ethane will be 700,000 tons. At least 2-2.5 million tons of gasoline obtained by direct fractionation of petroleum would have to be subjected to pyrolysis to obtain this amount of ethylene.

Foreign experience confirms the necessity and efficiency of using the ethane and propane contained in petroleum gas. Roughly 50 percent of the ethylene production capacities operating in the United States use ethane as raw material; ethane and propane together constitute about 77 percent of pyrolysis raw material (but in our country it is less than 23 percent).

Thus, using the ethane contained in petroleum gas (and the propane extracted along with the ethane) creates prerequisites for establishing a large complex of ethylene-consuming petrochemical or microbiological synthesis facilities in the Western Siberian region. In view of the scarcity of feed protein, it would be wise to organize a microbiological synthesis complex on the basis ofethanol for the purpose of producing protein-vitamin concentrates.

The question of using liquefied gas for municipal-domestic, industrial, and transportation needs in Tyumenskaya Oblast, above all in its northern petroleum and gas extraction regions, has hardly been studied at all. Organization of the production of liquefied gases at one of the refineries located in the middle of the petroleum and gas extracting regions of Western Siberia would help greatly in solving this problem and make it possible to reduce transportation costs to deliver liquefied gas and gasoline for motor vehicles to these regions.

Are We Able To Count Losses?

Despite the rise in the level of use of petroleum gas (in 1960 we used 56 percent of existing resources, while in 1975 it was 61 percent and in 1978 it was about 69 percent), losses continue to be great. Suffice it to say that in the Ninth Five-Year Plan absolute losses were more than 2.5 times greater than gas losses in the preceding five-year plan.

Why does this happen and is it inevitable? We will try to answer this on the basis of foreign and domestic experience.

In Canada and the United States 95-98 percent of existing petroleum gas resources are used. Indeed, the term "gas extraction" there is taken as self-explanatory, and they do not use our term "resources" and "extraction from resources." Practically all the gas is refined at gas refineries (about 92 percent in the United States).

In our "old" oil regions, Azerbaijan, Tataria, Bashkiria, Kuybyshevskaya Oblast, and several others, the level of use of petroleum gas is always quite high: 90-95 percent.

As a rule the greatest losses of petroleum gas take place in the new petroleum regions being brought into development in Western Siberia, the Komi ASSR, Turkmenistan, and elsewhere. The level of use of the petroleum gas in Tyumenskaya Oblast in 1977 was 35 percent. This petroleum region occupies first place in the country for petroleum extraction and also for losses of gas.

If we could raise the level of use of petroleum gas in the country as a whole to 80-90 percent of resources, it would be possible to obtain an average of 20-22 million tons of additional standard fuel per year (by the most modest calculations), or if this gas were refined, to get at least 0.7-1 million tons of ethane; 3-4 million tons of liquefied gas; 12-13 billion cubic meters of dry gas. This amount is equivalent to extracting roughly 15 million additional tons of petroleum and would make it possible to replace about 3 million tons of gasoline and 10-11 tons of mazut oil. Through pyrolysis of the abovementioned amounts of ethane and liquefied gases it would be possible to receive

1.7-2.3 million tons of ethylene. It takes 5.1-6.9 million tons of directly fractionated gasoline to receive such volumes of ethylene.

By selling the gas refining output that would have been received in the past five-year plan an additional 1.5-1.6 billion rubles of commodity output in existing prices and about 300 million rubles of profit would be obtained. This would reflect the growth in economic indicators for the sector if losses of petroleum gas were reduced.

The impact from bringing additional amounts of petroleum gas into national economic circulation would have been at least 280-320 million rubles for the five-year plan. Considering the higher use value of petroleum gas as compared to natural gas, it can be stated that in reality the impact would have been much greater.

Finally, the most important qualitative result of reducing losses of petroleum gas is the possibility of conserving resources of other types of fuel, above all petroleum, for future generations by lowering current rates of extraction or the possibility of using them at the present time to increase the country's economic potential. Let us explain what we mean by using the following thesis: "The market situation with world prices for petroleum and gas can have a certain impact on internal prices. Maintenance of world prices at their present high level objectively leads to a desire to increase the export of high-grade fuel."[2]

Bringing more of the petroleum gas now lost into the fuel-energy balance will make it possible to liberate an equivalent amount of petroleum for export and its sale at current world market prices will bring in at least 1.2-1.5 billion dollars a year.

We have been dealing with one aspect of the matter, the impact (result) which can be obtained by reducing losses of petroleum gas and bringing them into natural economic circulation. Now let us look at another side, the expenditures necessary to accomplish this.

According to our rough estimate, capital investments in the collecting, local (field) transportation, refining, and transportation of the output from petroleum gas refining to customers (hypothetically in the Ural-Volga and Central regions) with a petroleum gas use level of 80-90 percent will be 2-2.2 billion rubles or about 90-100 rubles per ton of standard fuel. According to our estimate, calculated expenditures (at the point of consumption) will be 24-26 rubles per ton of standard fuel where petroleum gas is used.

Comparing these data with figures on all-inclusive costs for gas and coal in the future given in the article cited above, we may conclude that the use of petroleum gas is more efficient because all-inclusive expenditures for the

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[2] Vigdorchik, A. G., Makarov, A. A., and Vol'fberg, D. B., "Problems of Long-Term Development of the Fuel-Energy Complex" TEPLOENERGETIKA 1979, No 2, p 5.

major regions of the country will be as follows (in rubles per ton of standard fuel):

	Gas	Coal
Center	40-42	35-37
Volga	37-39	30-32
Urals	35-37	25-27

How To Raise the Efficiency of Use of Petroleum Gas

The efficiency of use of petroleum gas can be raised by a thorough consideration of a number of interrelated factors. They can be classified in three groups: organizational-planning; technical; and economic.

The first step that permits an increase in the efficiency of the use of petroleum gas should be making time periods for construction and introduction of field structures close to or even the same as construction times for gas collection, transporting, and refining facilities.

We would have avoided such significant losses of petroleum gas in the Ninth Five-Year Plan if the capital investment appropriated for the development of gas refining in the 10th Five-Year Plan had been incorporated in 1971-1975, that is, at least five years earlier. If this capital investment and the material resources had been appropriated and put to use in 1968-1970 (perhaps even at the expense of a certain decline in the rate of petroleum extraction), by the 10th Five-Year Plan the level of gas use would have reached 80-85 percent of existing resources.

It appears that nonoptimal distribution of resources and mistakes and miscalculations in planning capital investment by sectors and subsectors of the fuel-energy complex took place here owing to a systematic underestimation of the role of petroleum gas. But, as calculations show, capital investment in the development of collection and refining petroleum gas is highly efficient.

This is illustrated by the experience of the developed petroleum powers of the world. In the United States there are laws that prohibit the exploitation of petroleum deposits without steps to insure use of petroleum gas below a certain level. As of 1 January 1978 the United States had 768 gas refineries with a capacity of about 750 billion cubic meters a year; each year they refined more than 470 billion cubic meters of gas (the use coefficient of capacity was about 62 percent). About 140 billion cubic meters of the total volume of refining was petroleum gas and the remainder was natural gas and the gas from gas condensate deposits.

In the United States it is considered profitable to refine even "lean" natural gases with liquid hydrocarbon (ethane, propane, butane, and the like) content at a level of 100-150 grams per cubic meter. In the United States 82 percent of the total volume of gas extracted is refined and the main job of gas refining in the United States and Canada has become maximum extraction of liquid hydrocarbons for use as raw material in petrochemistry and the production of liquefied gas for domestic needs. Ethane and liquefied gas are the

principal forms of pyrolytic raw material in the United States; in 1974 they were the source of 76.6 percent of all ethylene.

The situation is similar in Canada, where 201 gas refineries were being operated in early 1978.

The figures given illustrate our unjustified, wasteful attitude toward our own natural resources. It is becoming clear that we must work out a purposeful program to overcome the situation that has developed with the use of petroleum gas.

The development of technical equipment is a key element of such a program. This equipment must be created through the joint efforts of the sectors of machine building, instrument making, metallurgy, and industrial construction, and should include the following:

(a) developing and building highly efficient types of equipment and apparatus (compressors, pumps, refrigeration units, heat-mass exchange devices, control and measuring instruments) which work reliably and consistently under low-temperature conditions, which is important for the development of our northern region;

(b) development of an assortment of gas pipes and fittings for petroleum gas collection and transportation systems, including thin-walled types calculated for low pressure and applicable to collection and transportation of petroleum gas under the harsh natural and climatic conditions of the north;

(c) designing and developing industrial units in modular form, industrialization of methods of building and installing facilities for the collection and refining of gas.

Finally, it is desirable to reinforce organizational-planning and technical measures with effective economic measures. This refers above all to a revision of existing wholesale prices for petroleum gas and products of its refining so that they compensate for the costs of refining and guarantee the necessary level of profitability.

We also need a definite system of economic stimulation for the use of petroleum gas: penalties for losses and incentive for raising the level of use.

Petroleum Gas: New Directions

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 10, Oct 80 pp 62-72

[Article by A. I. Arutyunov, candidate of technical sciences and winner of the Lenin Prize, V. I. Luzin, doctor of economic sciences, V. P. Maksimov, doctor of technical sciences, winner of the Lenin Prize, All-Union Petroleum Gas Research Institute, and L. K. Tatevosyan, engineer, laboratory of the economics of gas refining at the All-Union Scientific Research Institute of Gas Industry, Moscow: "New Directions in Use of Petroleum Gas"]

[Text] Shortcomings in Traditional Use of Petroleum Gas Resources

An analysis of losses of petroleum gas shows that they are rooted chiefly in flaws in the traditional system of gas utilization. This system is based on gas refining at large refineries with subsequent transportation of the refined product to consumption points. The construction of gas refineries requires considerable capital investment, expensive and scarce equipment, and large specialized construction organizations. The construction time for many gas refinery facilities drags on, and until they are built more than half of the petroleum gas is burned off in flares because no local consumers are ready yet to use the petroleum gas that has been extracted (even for fuel). Moreover, the output of the gas refineries finds practically no use in the oil extraction regions and must be transported in long pipelines at high cost for many thousands of kilometers to the industrial regions of the country. As calculations have demonstrated, the traditional system of gas use is completely unacceptable for certain northern oil regions of our country because the cost and complexity of building industrial installations in those regions is multiplied manyfold and gas refineries are not an effective means of using the gas. The essential shortcomings of the gas refineries under these conditions are the following.

Prolonged construction. The experience of the last two decades shows that whereas gas refineries in the European part of the country are brought on line in 5-7 years, in Western Siberia and other remote regions the first capacities of gas refineries are introduced 13-15 years after the beginning of petroleum extraction. During this time up to 80 percent of the gas reserves which they were being built to refine are lost, which by itself confirms the proposition that gas refineries are unsuitable to solve the problem of efficient and complete use of petroleum gas resources.

Low level of provision with raw materials. Most of the gas refineries are designed and built to refine the "peak" output, which is to say the maximum extraction, at the particular deposit (or group of nearby deposits), but because of delays in planning and construction time they are launched quite late. As a result they are fully provided with raw material only in the first 5-7 years of operation, after which the coefficient of loading declines and therefore the already low economic indicators of their work become worse. Even the new Western Siberian gas refineries begin to experience raw material "famine" after 5-6 years. It is hard to find any other sector in which large enterprises have such an unsatisfactory supply of raw material.

The impossibility of supplying gas refineries with gas from other, relatively remote deposits. This negative phenomenon is a result of the fact that the problem of pumping undried petroleum gas that has not been subjected to stripping through gas pipelines has not been solved in practice. Therefore, the attempt to supply gas refineries with gas from other deposits, even those located comparatively close, becomes impossible and new refineries with appropriate gas and product pipelines must be built at the new deposits.

The high cost and great complexity of supplying equipment for construction. The modern gas refinery is a large and intricate complex of engineering facilities. The large gas refinery has a low level of industrialization in

construction and is not suitable for transition to modular building systems because it involves so many types of petrochemical equipment (often individually manufactured, compressors, fittings, control-measuring and automation instruments, and other scarce and specialized equipment.)

Gas refineries can be built only by large and specialized construction-installation organizations. It takes many years to put together such organizations in new, remote oil regions, which of course does not help reduce construction time. The gas refinery needs a large staff of service personnel. A refinery that refines 2 billion cubic meters a year under our conditions requires 160-180 industrial personnel and an equal number of nonindustrial employees. Municipal and domestic facilities such as residential buildings, schools, stores, nursery schools and daycare centers, hospitals, polyclinics, dining halls, and the like must be built to serve them. The costs involved in this snowball.

The output of gas refineries, the "broad fraction" and "dry" gas, are not sold on the spot. Therefore, to market the output of the gas refinery, that is the "dry" gas and "broad fraction," especially in the remote regions, it is necessary to construct long gas and product pipelines which cost 2-3 times as much as the refinery itself. Thus, the need for transportation lines significantly increases the volume of capital investment in the system of marketing gas resources under the traditional scheme, which makes it even less efficient for remote regions.

The New Direction in the Use of Petroleum Gas Resources

After a critical analysis of traditional ways of using petroleum gas we can formulate the basic requirements for more efficient use of resources of this product:

(a) industrial installations that prepare and use petroleum gas should be launched concurrently with the beginning of petroleum extraction so that all gas extracted at the particular deposit can be dried and marketed at the right time;

(b) these installations must be built in modular, transportable, easily installed, fully plant-manufactured units. These features of the units make it possible to avoid significant volumes of construction-installation work and build up or reduce refining capacities according to volumes of gas extracted on an operational basis, at low cost;

(c) industrial installation should be reliable in operation, simple to service, and fully automated;

(d) new engineering facilities to collect, prepare, and use gas should provide a significant decrease in selling costs.

In view of this it seems to us that the most rational approach in remote petroleum regions is to make maximum use of the gas right where it is extracted, chiefly for the energy needs of petroleum extraction itself. In this case it

is possible to avoid building such expensive and complex engineering facilities as gas refineries, gas pipelines, product pipelines, power transmission lines, and the like.

Practical implementation of the new principles of using gas resources can be represented in the following order.

From the very initiation of exploitation of the petroleum deposits modular units are installed at the petroleum and gas collection points in the fields for low-temperature condensation of the petroleum gas. The cold air for them is produced by modular units with screw-type compressed gas motors (called in Russian "detandery" — machines for cooling gas by expanding it). These units completely replace gas refineries. The essential technical features of the new system are as follows. The output from the oil wells goes to the separation unit of the first stage. The gas that is removed in the petroleum separators is sent to a "screw-type compressed-air motor" installation which consists of a series of aggregates in which the gas is expanded to produce the cold used to remove the gasoline and dry the raw gas. Then the gas is sent to gas turbines as a fuel in order to satisfy local energy needs. At first the "broad fraction" is pumped directly into the petroleum pipeline.

Screw-type compressed-air motors essentially replace traditional gas refineries and are small, modular units manufactured entirely at the plant which can be installed as part of petroleum and gas collection points at oil fields and will prepare the gas concurrently with the beginning of petroleum extraction. This is the basic condition for full use of petroleum gas resources.

The screw-type compressed-air motors were built through the joint efforts of the Krasnodar Polytechnic Institute and the All-Union Scientific Research Institute of Petroleum. An experimental unit was adopted by the inter-departmental commission back in 1975. In 1976 USSR Gosplan adopted a decision to establish machine building capacities to produce them and two experimental industrial units were manufactured at the Oktyabr'skiy Plant in 1980.

The compressed-air motor installation can have capacities that make it possible to process some 30,000 to 1,000,000 cubic meters of gas a day. The installation that processes 100 million cubic meters of gas a day will probably be most widespread.

The advantages of compressed-air motor installations over conventional gas refineries are shown in Table 1 below which compares the technical-economic indicators of a hypothetical gas refinery designed to refine 1 billion cubic meters of gas a year from regions of Western Siberia with four compressed-air motor installations each producing 250 million cubic meters of gas a year.

The figures in Table 1 show that under Western Siberian conditions replacement of a conventional gas refinery with compressed-air motor installations gives output of practically the same value (only the production of propane decreases) and makes it possible to cut capital investment by almost 10 times and operating costs by three times.

This demonstrates the comparative economy of preparing petroleum gas using compressed-air motors and conventional gas refineries.

Table 1. Technical-Economic Indicators of Comparable Technologies for Processing Gas.

Indicators	Gas Refining Using Gas Refineries	Modular Field Gas Processing Installations with Compressed Air Motors
Productivity, millions of m^3/Year	1,000	1,000
Annual Production of Commodity Output:		
Stripped Gas, millions of m^3	830	870
Broad Fraction, tons	315,000	275,000
Capital Expenditures, %	100.0	10.0
Total Annual Operating Expenditures, %	100.0	36.0

Evaluation of Petroleum Gas as an Energy Carrier for Local Power Systems

In connection with the proposal to use petroleum gas for local energy needs it is necessary to evaluate the amount of energy which can be produced from the gas that is extracted together with the petroleum and compare it to the need of the particular petroleum and gas extracting enterprise. For this purpose we have calculated the balance of gas extraction and consumption for a hypothetical deposit which extracts 86,000 tons of petroleum and 6 million cubic meters of gas each day (fairly typical parameters for small producing deposits).

After stripping, drying, and inevitable losses (which take away about 25 percent), the amount of gas which can actually be used for energy needs is set at 4.5 million cubic meters a day. The heat value (capacity) of the stripped gas is about 8,000 gigacalories per cubic meter. About 2.5 kilowatt-hours of electricity can be produced from each cubic meter of such gas with conventional comparatively small internal combustion engines under oilfield conditions. Thus, the daily energy resource from petroleum gas at the deposit will be 11 million kilowatt-hours.

The approximate daily needs for energy resources for the basic processes of such a petroleum deposit are as follows:

(a) well drilling — 960,000 kilowatt-hours (for 20 drilling rigs with capacities of 2,000 kilowatts);

(b) operation of wells — 3,500,000 kilowatt-hours (removing one ton of petroleum and one ton of water per second from a depth of 1.5 kilometers with an overall energy system efficiency of 0.2);

(c) collection and gas transportation within the field — 375,000 kilowatt-hours (total pressure losses for pumping — 40 atmospheres);

(d) pumping water into the layer — 3,750,000 kilowatt-hours (for a pumping volume equal to a double take-off of layer fluid, injection pressure of 200 atmospheres, and pumping system efficiency of 0.5);

(e) water supply — 960,000 kilowatt-hours (four cubic meters of water a second pumped through water lines, pressure at the beginning of a line — 60 atmospheres, system efficiency — 0.6);

(f) external petroleum transportation — 2,700,000 kilowatt-hours (under the following conditions: distance to trunk pipeline — 1,000 kilometers, number of pumping plants — 10; pressure at the approach to a station — five atmospheres, after the station — 75 atmospheres; amount of petroleum being pumped — one ton per second; generalized efficiency of the pumping units — 0.6);

(g) heating petroleum during demulsification (to 15 degrees C) — 4,000 kilowatt-hours;

(h) Other expenditures -- 250,000 kilowatt-hours.

Total energy usage per 24 hours here is approximately 16.5 million kilowatt-hours. A very important conclusion follows from this calculation: the energy requirements to exploit and operate a deposit may in large part be filled by the energy resources of petroleum gas extracted together with the petroleum.

The above balance of extraction and consumption of gas for local power needs is approximate. Specifically, there may be a significant reduction in the amount of gas used to heat petroleum during demulsification by replacing it with the hot exhaust gases of gas turbines. Then, after replacing the electric motors at pipeline pumping plants with gas turbines working on liquid fuel it is possible to significantly reduce gas usage to produce electricity for these needs.

Modular Power Plants and Gas Turbines for Local Oilfield Energy Use

To evaluate the feasibility of switching a number of oilfield processes to a local energy system fueled by petroleum gas it is necessary to consider the capabilities of the Ministry of Petroleum Industry for production and delivery of modular power plants and gas turbines as power units for oilfield equipment.

In world practice today gas turbine drive units are used for various machines and mechanisms. They have found broad application in the petroleum industry. The primary advantages of gas turbines are low specific weight per unit of capacity, mobility, simplicity of automation, and the ability to operate on different types of fuel and produce electricity and thermal energy (this is especially important for energy supply to oilfields in the northern regions). The possibility of delivering petroleum gas to turbines at a natural pressure of 3-6 atmospheres without compressor plants significantly reduces the cost and shortens the time of construction. Moreover, reducing the requirements for depth of drying and stripping of the petroleum gas used as fuel simplifies

and reduces the cost of the process of preparing it in compressed-air motor units.

At the present time about 80 large foreign companies manufacture gas turbines. Gas turbine building is also developing in the USSR. A few years ago the Ministry of Gas Industry established the All-Union Science-Production Association Soyuzturbogaz (USSR Gas Turbine Association). Most of the large domestic gas pipelines are equipped with gas pumping units based on gas turbines.

Moreover gas turbines from the series of aviation engines are used in various other sectors of industry. Gas turbines are produced by the Ministry of Shipbuilding Industry. Each type of gas turbine can serve as the basis for establishing modular power plants; the number of such plants is also growing steadily. The Mobile Power Plant Trust has been operating for several years within the system of the Ministry of Power and Electrification.

It should be observed again that local energy production can be especially efficient for energy supply to petroleum fields because it can produce both electricity and thermal energy, and in the remote northern regions the latter is extremely necessary for both industrial and municipal-domestic needs. Of course, the amount of thermal energy received from gas turbines is almost three times greater than the equivalent amount of electricity.

Local energy production has one more advantage.

Transportation of the energy carrier (petroleum gas) to the gas turbines can be accomplished without compressor plants, at a pressure of just 3-6 atmospheres. This removes the necessity for large capital investment in the construction of compressor plants, which greatly simplifies and reduces the cost of the entire system of oilfield gas transportation, sharply cuts costs for electricity production, and reduces construction time.

In order for the domestic petroleum industry in remote regions to switch to self-sufficient energy systems, we must begin developing a stock of modular power plants and comparatively large aggregates for pumping water and petroleum using gas turbines in models built for northern conditions. They will make it possible to use petroleum gas resources quite completely and supply energy for the processes involved in petroleum extraction.

In the preceding section it was established that an installed capacity of roughly 500,000-600,000 kilowatts (12-14 million kilowatt-hours a day) is required to exploit a certain hypothetical deposit with annual extraction on the order of 30 million tons (daily extraction of 86,000 tons). Therefore, with modular (or semipermanent) units with gas turbine drive of 10,000 kilowatts, roughly two such stations (or three with a stand-by unit) would be needed per million tons of annual extraction.

The Economic Efficiency of the New Direction

For a rough determination of the economic efficiency of the new direction of use of petroleum gas resources we have adopted a methodology based on a comparison of the volumes of capital expenditures necessary to use petroleum gas

resources under the traditional system and the corresponding indicators for our proposed scheme. To make this calculation we will consider a hypothetical petroleum extracting region with two large deposits, each one producing 15 million tons of petroleum and 1 billion cubic meters of gas annually. The distance between the deposits is taken to be 200 kilometers, and they are located in a region 1,000 kilometers from the receiving point for transported petroleum, gas, and "broad fraction."

Under the traditional system energy is delivered from a large regional thermal power plant working on gas fuel (which may include petroleum gas extracted at these deposits). The power plant is located 1,200 kilometers from the deposits. Table 2 below gives a list of the basic industrial production facilities and the volumes of capital investment necessary under the traditional and proposed new systems for use of petroleum gas resources. Petroleum pipelines are not included among the facilities because they will be built in either case.

Table 2. Comparative Data on Capital Investments for Different Systems of Use of Natural Gas Resources.

Facilities	Capital Investment, rubles
Traditional System	
Gas Pipelines for Raw Gas with Compressor Plants	40,000,000
Gas Refinery	80,000,000
Gas Pipeline After Gas Refinery with 12 Compressor Plants	240,000,000
Product Pipeline for "Broad Fraction" with 10 Pumping Plants	160,000,000
Power Transmission Line (Double)	60,000,000
Regional Gas-Burning Power Plant	150,000,000
Total	730,000,000
Proposed New System	
Units with Compressed-Air Motors	10,000,000
Modular Power Plants and Gas Turbine Drives with Total Capacity of 500,000 kwt	100,000,000*
Reserve of Modular and Gas Turbine Drives	50,000,000
Total	160,000,000

* Average specific capital investment per kilowatt of capacity of power plants and gas turbine drive.

These calculations show that the proposed system for using petroleum gas resources for local energy needs with preliminary gas processing in units with compressed-air motors requires, under the assumed conditions, just one-tenth

of the capital investment needed for the traditional system with gas refineries, a gas pipeline, a product pipeline, power transmission lines, and a large regional thermal power plant.

If it is assumed that a deposit with the same indicators is just 500, not 1,000 kilometers, from the receiving points for petroleum, gas, and the "broad fraction," in this case too the savings on investment will be a significant amount, and this confirms the high efficiency of the recommended course for use of petroleum gas resources. The high national economic efficiency of the proposed system is based on the higher level of use of natural gas resources. In cost terms this efficiency will exceed the indicated capital investment savings many times.

According to future plans for work to make use of petroleum gas resources (under the traditional technology) about 4 billion rubles of capital investment is contemplated in the next two five-year plans. Calculations show that if the proposed system for use of natural gas resources were adopted instead at least 3 billion rubles could be saved while putting the same volume of gas to use.

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FUELS

UDC 553.552.5 (477.6)

ON INDUSTRIAL PRESENCE OF GAS IN THE LOWER PERMIAN CHEMOGENIC DEPOSITS

Kiev NEFTYANAYA I GAZOVAYA PROMYSHLENNOST' in Russian No 4, Oct-Dec 80 pp 5-8

[Article by A. V. Boboshko, N. A. Dudko, L. S. Kaplin, Ya. I. Kolomiyets, B. P. Sterlin, M. G. Ul'yanov, L. I. Shekhtman, O. E. Yakovlev (Ukrgazprom, UkrNIIgaz, Ukrburgaz)]

[Text] The Mashevskoye gas-condensate formation is confined to the brachial anticline of the same name located in the southeastern part of the Dneprovsk-Donetsk depression. The fold is bounded on the north by a compensating North-Mashevskiy flexure and on the south, it is separated from the Sukhodolovskoye and Anreyevskoye upheavals by the Tagamlykskiy flexure of a similar genesis. The western pericline of the Mashevskoye upheaval changes over to the Yelizavestskaya structure.

The upheaval is complicated by the Seleshchinskiy salt stock of the Preupper Permian level break which, according to drilling and seismic exploration data, has an asymmetrical mushroom shape.

Some 32 exploration and 12 operational wells were drilled at the deposit. Industrial accumulations of gas and condensate were detected at the northern wing of the upheaval. The explored gas-condensate massive-strata formation is confined to the terrigenous deposits of the Kartamyshskaya Lower Permian formation (level P-2) and the Araucarite formation of the Upper Carboniferous period (levels K-1, K-2 and K-3). The basic productive K-2 level contains over 20 billion m^3 of gas. The gas-water contact was determined at a level of 4020.5 meters.

Possible gas-bearing strata were detected in wells 20, 21, 24, 29, 40, 47, 103 and 106 in accordance with the results of industrial-geophysical investigations in the Lower-Permian chemogenic deposits. They were not tested because of industrial inflows from the underlying terrigenous Upper Carbonaceous-Lower Permian formations.

Direct indications of the presence of gas in the chemogenic strata were found in the process of sampling well 9 in which, after perforating level P-2 of the Kartamyshskaya upheaval, the gas yield through a 2.5mm collar was $1600 m^3$/day. After perforating the Nikitovskaya and Slavyanskaya upheavals at a number of intervals, the yield increased to 40,000 m^3/day.

In 1977, the Ukraine Geophysical Expedition of the "Soyuzgazgeofizika" Trust made some industrial-geophysical studies in a gas medium in well 9. Intervals 3058.8 - 3050.4 and 3004 - 2994 meters, stratigraphically corresponding to the S_2^1 and S_2 strata of the Slavyanskaya upheaval (the Bryantsevskaya and Sub-Bryantsevskaya rhythmic benches) were found to be gas-producing. However, in spite of the results obtained in well 9, the question of the presence of an industrial gas deposit in the chemogenic strata of the Mashevskoye formation remained unsolved.

On the basis of the concepts on the possible regional nature of the gas-bearing of the chemogenic strata of the Lower Permian DDV [1], the Ukrgazprom explored the above-named formations at the Mashovskoye deposit in 1979. Wells 50 and 112 were tested for this purpose.

When sampling operational well 112 in the process of drilling in pipes with a strata tester, the industrial presence of gas was established in the 2877 - 2984 meter interval, corresponding to the Above-Bryantskaya and Bryantskaya rhythmic benches of the Slavyanskaya upheaval. The strata pressure was about 350kg-force/cm^2. Well 112 is located in the eastern sector of the basic productive stock of the formation (Figs. 1, 2).

When sampling exploration well 50, located 5km to the east of well 112, an industrial gas yield of 103,400 m^3/day was obtained at the collar for R_{pl} = 126 and R_{zatr} = 140kg-force/cm^2 from the perforation interval of 2750 - 2956m (the Bryantsevskaya, Above-Bryantsevskaya and Krasnosel'skaya rhythm benches of the Slavyanskaya upheaval).

Thus, a new industrial gas deposit was found in wells 112 and 50 on the Mashevskoye formation in the chemogenic deposits of the Lower Permian.

Due to the lack of core samples, the type of collectors can be conjectured only by analogy with known gas deposits in the Lower Permian chemogenic strata of the southeastern DDV where the collectors are of the porous-fissured type.

With respect to its morphology and structural position, the gas deposit can be considered, to the first approximation, a platform of the Melikhovskaya and Kogichevskaya type. It is interesting to note that the presence of industrial gas in the chemogenic strata was established by well 50 in that part of the formation where gas deposits were not detected by exploration in the underlying formations of the Kartamyshskaya and Araukarite upheavals.

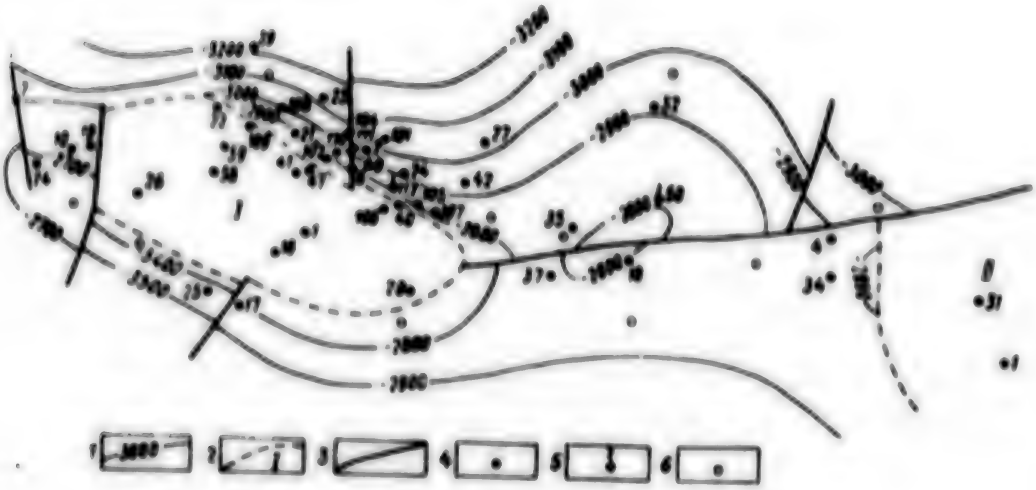

Fig. 1. Structural map of the Mashevskoye formation:

1. bottom ipsohypses of the Bryantsevskaya rhythmic bench of the Slavyanskaya upheaval;
2. the contour of salt stocks (I -- Seleshchinskiy stock of rock salt. II -- Yelizavetovskaya);
3. tectonic faults;
4. exploration and operational wells;
5. wells with industrial gas presence in the chemogenic Lower Permian strata;
6. wells planned for exploring gas deposits in the Lower Permian chemogenic strata.

As in all deposits in the chemogenic strata of the Lower Permian DDV [2], the gas deposit of the Mashevskoye formation is characterized by AVPD [expansion unknown]. However, the anomaly coefficient here is 1.2 and is the lowest of those recorded in the chemogenic strata. Another gas-dynamic feature of this deposit should be noted. In the majority of gas accumulations in the chemogenic strata, below which are located massive-strata deposits (the Melikhovskoye, Yefremovskoye and the Kegichevskoye formations), the strata pressures in the roof correspond to strata pressures in the anticline or are higher. At the Mashevskoye formation, the pressure in the chemogenic strata is considerably lower than in the roof of the underlying massive-strata deposit. This was the reason why, in exploring and operational wells, no gas was detected when drilling through the chemogenic strata.

The above cited data introduce considerable correction in the established concepts on the gas dynamics of deposits in chemogenic strata and provide a basis for reviewing the prospects of the presence of gas in a number of areas where no gas was observed in the process of drilling with relatively low solution densities.

In our opinion, the presence of industrial gas in the Lower Permian chemogenic strata of the Mashevskoye formation is not limited by the northern wing and eastern pericline. The western pericline, the southern wing of the fold and the area of junction with the Yelizavetoskaya stock are promising.

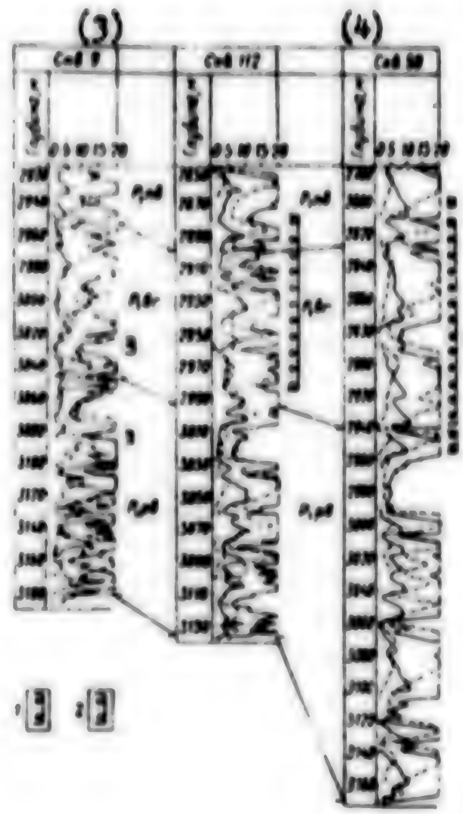

Fig. 2. Comparison between cross sections of the Lower Permian chemogenic strata in the wells of the Mashevskoye formation:

1. productive strata confirmed by tests
2. industrial gas-bearing strata according to test data by strata-tester in pipes
3. well 9
4. depth, meters

The method of further exploration depends on the assumed shape of the natural reservoir in the chemogenic strata. The detected gas deposit within the boundaries of the northern wing and the eastern pericline may be compared to deposits in the same strata of the Melikhovskoye and Kegichevskoye formations. Therefore, taking into account the experience of their exploration, the gas deposit being characterized should be explored on the basis of the assumed area distribution of the collectors with "windows" of the absence of the latter. It is advisable to locate the following wells more or less uniformly over the area and, in

determining the "spacing" of the exploration, take into account the reinterpretation results of the industrial-geophysical investigations in previously drilled wells. For the possible organization of work on a new area, it is advisable to explore the northern dip of the Mashevskaya fold and the Yelizavetskiy stock.

On the section adjoining from the north to the Seleshchinskiy stock, we assume geological conditions are close to those at the Novoukrainskoye and Raspashnovskoye formations where, under a thick "overhang", there are encountered productive chemogenic Lower Permian deposits overlying along the tectonic contact petroleum and gas-bearing strata with steeper dip angles of the Carbonaceous period.

The assumed shape of the reservoir here is a band stretched along the Seleshchinskiy stock. It is advisable to explore it by drilling independent wells locating them along the course of the reservoir. In this case, the planned depths of the wells should provide for uncovering the GVK [expansion unknown] level of the basic massive-strata deposit.

The southern part of the Mashevskoye formation was studied little by drilling, but it is characterized by block structure. Probably, there natural reservoirs in the chemogenic strata may be restricted by high amplitude discontinous faults controlling industrial gas-bearing. It is advisable to drill at least one independent well in each block.

Positive results of testing chemogenic deposits in the Lower Permian at the Mashevskoye formation confirm the concept on the Lower Permian chemogenic DDV as an autonomous object of exploration.

As is well known, the industrial accumulations of gas in chemogenic formations (the Melikhovskoye, Kegichevskoye, Yefremovskoye, Staroverovskoye, Krestishchenskoye and other formations of the southeastern DDV) were detected as a result of the manifestation of gas when drilling wells in the underlying terrigenous deposits of the Upper Carbonaceous period containing the basic massive-strata formation. The industrial gas bearing of chemogenic deposits on the Mashevskaya area was established on that section of the formation where results of previously drilled wells were negative testing the Upper Carbonaceaus period deposits, and the presence of gas was not manifested when drilling the chemogenic strata of the Lower Permian.

All industrial gas accumulations found up to now in the Lower Permian chemogenic deposits DDV were stratigraphically confined to the undersalt part of the Under Brantsevskaya rhythm bench of the Slavyanskaya formation. Nonindustrial gas demonstrations were noted also at other stratigraphic levels of the Bakhmutskaya series. Industrial inflows of gas on the Mashevskaya area were obtained at new levels -- the Bryantsevskaya and Over Brantsevskaya formations.

What was stated above provides a basis for involving the area beyond the boundaries of the established gas-bearing deposits of the underlying terrigenous formations in exploration, expanding it to the entire cross section of the

Nikitovskaya and Slavyanskaya formations, as well as the reconsideration of the evaluation of the prospects of formations where drilling into the chemogenic strata of the Lower Permian produced negative results.

The exploration of gas deposits in the Lower Permian chemogenic strata DDV needs a new methodological approach based on concepts about the reservoir genesis, sources of gas formation and conditions of gas accumulation, gas-hydrodynamics of porous-fissure collectors and, especially the methods of their isolation, detection and sampling.

The solution of these problems will increase the efficiency of prospecting and exploration work on gas in the Lower Permian chemogenic strata of the Dneprovsk-Donetsk depression.

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CSO: 1822

UDC 622.276.8

DESALINATION OF PETROLEUM WITHOUT USING FRESH WATER

Kiev NEFTYANAYA I GAZOVAYA PROMSHLENNOST' in Russian No 4, Oct-Dec 80 pp 22-24

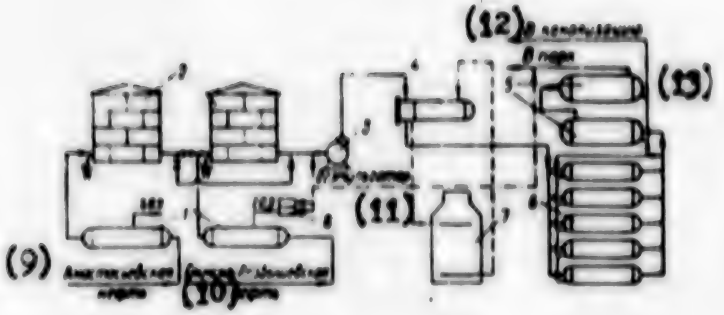
[Article by S. G. Maryak, V. F. Ivanets, V. P. Mordonenko, S. F. Moiseykov (Ukrneft', UkrgiproNIIneft')]

[Text] Studies were made at the Glinsko-Rezbyshevskaya installation for petroleum preparation (UPN) on the desalination of petroleum by the "installation -- commercial depot" arrangement without using fresh water.

For this purpose, two electrical dehydrators, operating in the thermal sedimentation mode (see Fig.), were inserted in the technological arrangement and, since September 1977, concentrated deemulsifier has been fed to two points: to the intake of raw material pumps and into the dehyrated petroleum at the exit from the installation.

The dehydrated petroleum, containing up to 0.7% water at stable operation of the UPN, as before [1], was mixed in the reservoirs of the commercial depot with a gas condensate which, after separation of the basic mass of water, is classified in accordance with the II group of quality (GOST 9965-76). The petroleum and condensate mixture, after over two hours of settling and after disposal of the separated water was pumped from commercial reservoirs to the consumer.

The characteristics of the process and the quality of petroleum preparation are shown in the Table. It may be seen from the Table data that feeding half the total consumption of the deemulsifier into the dehydrated petroleum made it possible to increase the volume of highly desalinated petroleum and condensate by an average of 36% in the fall-winter period, and deliver them in some months as up to 93-100% of the first group of quality.



Technological arrangement of the Glinsko-Rozbyshevskaya installation for petroleum preparation:

1. Separator
2. Raw material reservoir
3. Raw material pump
4. Heat exchanger-heater
5. Electric dehydrator
6. Thermal sedimentation tank
7. Furnace for heating circulation water
8. Dosing pump
9. Anastas'yevskaya petroleum
10. Glinsko-Rozbyshevskaya petroleum
11. Deemulsifier
12. To drainage system
13. To depot

Thus, the use of the batch feed of the deemulsifier to the dehydrated installation made it possible to obtain highly desalinated petroleum and reduce the deemulsifier consumption in the commercial depot by 10%. The reduction in deemulsifier consumption at the dehydration stage increased the water content in the petroleum that left the installation in January-March 1978 to 0.15% on an average.

The obtained effect is due to the intensified coalescence of the emulsions in the pipeline and the improved conditions of the preparation of petroleum and condensate in commercial depots. The latter is related to an increased consumption of deemulsifier used directly for condensate preparation and petroleum being washed in a layer of subcommercial water ("water bed"), enriched by the reagent.

Table

Characteristic of process and quality of petroleum preparation at the Glinsko-Rozbyshevskaya UPN

Year, Month	Productivity of installation, %	Dehydration temperature, °C	brand	unit consumption, grams/ton	Water content in prepared petroleum, %	Petroleum and condensate released by groups of quality, %		
						I	II	III
1977								
Jan.-Aug.	84	40	4411 R-11	62	-	55	40	5
September	84	Not measur.	4411	54	Not deter.	84	16	-
October	80	39	4411	50	"	86	14	-
November	84	40	4411	56	"	93	3	4
1978								
January	91	39	4411	51	0.19	98	2	-
February	82	38	4411 K-3-Ye	52	0.03	100	-	-
March	84	41	4411	62	0.22	88	12	-

Note. Data for April and December 1977 was not included because the installation operated for a long time without the petroleum being heated.

When using the old technology, the entire volume of deemulsifier was fed to the raw petroleum with a 60% water content which led to the loss of its dissolving part in the water discharged from the sedimentation tanks. This is equivalent to overconsumption of the deemulsifier for petroleum preparation at the installation and a reduction in its consumption for dehydrating the condensate in the reservoirs, and coalescing drops in the dehydrated petroleum as it moves in the pipeline. This is confirmed by the efficient operation of the UPN using the K-3-Ye deemulsifier which is practically insoluble in water (see Table).

Coalescence plays a large role in stratifying petroleum emulsion in commercial reservoirs. If it is assumed that the improvement of the quality of the mixture delivered from the installation is related only to the improvement of the concentrate dehydration process, then when its ratio is about 25% of the total volume, the maximum increase in the ratio of petroleum of the first group of quality should have been about 80%. Nevertheless, the volume of petroleum

of the first group of quality delivered reached over 90%. It is difficult to assume that a brief nonintensive mixing of petroleum with condensate in the receiving branch pipes of the reservoirs with subsequent washing in the layer of subcommerical water can provide for the changeover of the entire produced concentrate to the first group of quality.

It appears that the intensification of the emulsion coalescence of the dehydrated petroleum along with the positive action of the deemulsifier, is due to the improvement in the hydrodynamics of its motion, related to the increase in the water content. This assumption agrees with the results in papers [1, 2] and indicates that the repeated introduction of the reagent is necessary to achieve the optimal water content in the petroleum.

We will evaluate the technical-economic indicators of the cited results as compared to the usual method of thermo-chemical desalination. We will assume for this purpose that the combined preparation of petroleum and condensate is done at the installation, as well as feeding fresh water, for example, ahead of the last in the technological chain, additionally connected sedimentation tank. We will assume that the unit deemulsifier consumption at the dehydration stage for obtaining the first group of quality petroleum must be increased by about 10 grams/ton proportionally to the increase in the volume of preparation. This increase in deemulsifier consumption is not underestimated. The optimal hydrodynamic conditions for the mixture motion ahead of the sedimentation tanks in this case may be selected according to results [1, 2] by regulating the depth of the preliminary water discharge in the raw material reservoirs.

Let us assume that feeding fresh water in an amount of 5% of the petroleum volume will provide extensive desalination [3]. A reduction in deemulsifier consumption from 54 to 37 grams/ton of petroleum and condensate will be 0.0136 rubles in terms of money. Unit costs of consuming and utilizing fresh water at the "Poltavaneftegaz" NGDU [Petroleum-Gas Producing Administration] are 0.018 rubles/ton of prepared petroleum, for a cost of pumping and purifying $1 m^3$ of water of 0.36 rubles. These approximate calculations indicate that the additional feed of deemulsifier to the pipeline with the dehydrated petroleum is, if not preferable, at least equivalent to the use of fresh water for obtaining extensively desalinated petroleum.

... a technology that specifies a batch feed of deemulsifier to the dehydrating in[...]allation for the purpose of obtaining an extensively dehydrated petroleum may be recommended for petroleum regions with an acute shortage of fresh water.

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2291
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FUELS

CONFERENCE ON UNDERGROUND MINING OF COAL AND SHALE

Moscow UGOL' in Russian No 11, Nov 80 pp 60-63

[Article by A. Ye. Vidulin and V. L. Grigor'yev, candidates of technical sciences (IGD imeni A. A. Skochinskiy), B. Ye. Gretsinger, doctor of technical sciences, (IGM Ukraining SSR Academy of Sciences): "Conference of Underground Coal and Shale Section of the Scientific Technological Council of the USSR Minugleprom [Ministry of the Coal Industry]]

[Text] An expanded conference of the Underground Mining of Coal and Shale Section of the Scientific Technological Council [NTS] of the USSR Minugleprom was held at Dnepropetrovsk in the Geotechnical Mechanics Institute of the Ukrainian SSR Academy of Sciences. It discussed the progress of the fulfillment of the plan of scientific research work of the institute in the Tenth Five-Year Plan period, and the plan of work on underground mining problems in the 11th Five-Year Plan period.

Five reports and 11 speeches were given at the conference.

A. S. Kuz'mich, chairman of the NTS Section, in opening the conference, stressed the special importance of deep mines for the basic basins in the country, primarily, for the Donetsk basin. He also stressed that, at present, the investigation of the effects of natural factors that show up at greater depths in the process of mining minerals, progressed considerably. The problem of developing coal deposits at great depths is becoming more acute; however, the results achieved so far do not fully meet production requirements.

V. N. Poturayev, IGM [Hydromechanics Institute] director, reported that the institute's collective jointly with other institutes of the USSR Academy of Sciences, the Ukrainian SSR Academy of Sciences, the USSR Minugleprom, the Ukrainian SSR Minugleprom and the USSR MBO [Ministry of Higher and Secondary Specialized Education] obtained the most considerable results on the problems of combatting sudden ejections of coal, rocks and gas; studying the physiomechanical properties and stress-deformation condition of rocks; studying the fracture of rocks and coal; developing scientific bases and technical facilities for mining coal without the constant presence of people at the stope; developing methods for determining the presence of gas in seams and studying the gas composition; studying the aerodynamics of the mining sections and overcoming the gas barrier when the load on the longwall is increased; combatting dust; developing automatic systems for

designing and controlling mine ventilation; monitoring the mine air; developing new combines and improving existing ones for mining in solid rocks, including rocks dangerous with respect to ejections; developing nontraditional methods for coal mining, etc.

In his report, A. F. Ostapenko (Ukrainian SSR Ugleprom) stressed that it is necessary to introduce new equipment and improved technology in mining coal in order to increase the rate of mining by 11 to 15 meters per year in depth.

The course on increasing the mechanization of extraction and preparatory work in deep mines requires new special-planning solutions on methods of preparation and systems for working coal seams. Of the panel, horizontal and multistage methods now in use for preparing mine fields, the most progressive are the first two whose share in the flat and steep seams is 45 and 22% respectively of the longwalls in operation. Their ratio will increase considerably in the future.

Investigations and accumulated experience have indicated that the safety and efficiency of labor, as well as the operating reliability of modern mining equipment requirements are met by working in long columns along the direction and rise of the seams. However, in connection with the greater complexity of geological-mining conditions as the mines become deeper, the share of the column system of working decreases considerably, and a continuous system of working with driving drifts behind the longwalls is comparatively more widely used.

It is necessary to complete as soon as possible work on creating complexes with mechanized timbering and standardized tunneling machines for the full mechanization of mining in steep seams of over 0.7 meters thick with side rocks of any stability, which will make it possible to expand the range by using comprehensive mechanization facilities.

No less important is the problem of tunneling and maintaining drifts of considerable lengths in deep mines, as well as in preparatory drifts that are operated for a relatively short time. It is advisable to tunnel and maintain the first ones in the preliminary unloaded solid mass, as well as at the foot of the seam or along caved-in rocks behond a specially tunneled unloading longwall (Mine imeni Bazhanov). The second ones must be tunneled with an increased cross section by locating the conveyor transport mains on suspension members and using holes for unloading the solid mass. Also efficient is tunneling such drifts in pairs, filling the worked-out space between them with rocks (using KsV type complexes).

In their report. Yu. L. Khudin and G. A. Katkov (the IGD [Institute of Mining imeni A. A. Skochinskiy]) gave an analysis of the working conditions in the deep mines of the Donets basin. They also described the specifics of the coal seam bedding in the Kuznetsk and Karaganda basins and outlined prospects for working mines as their depths increase. They indicated the necessity of developing and implementing comprehensive technical and technological measures and scientific investigations on the study of the condition of the rock mass; providing for the stability of the drifts; developing safe methods for controlling roofs at working stopes; localizing gas-dynamic phenomena and temperature changes, etc. The IGD imeni A. A. Skochinskiy is doing scientific research work along this basic direction.

New technological schemes for uncovering, preparing and finishing off seams of average thickness were developed. The following main solutions were at the basis of the schemes:

methods for preparing the mine field, panel, level, cutting section without pillars that would make it possible to extract the coal more fully;

locate the drifts in zones relieved from rock pressures;

maximum concentration of mining in a level independently of the number of simultaneously operating longwalls and seams worked.

dispersal and independent stope and preparatory work in a level that makes it possible to transport loads according to a separate arrangement.

use short extraction fields by finishing them off by long columns along their directions with the following extinction of the drifts after the advance of the working stopes;

use direct-flow arrangements for ventilating working stopes with the freshening of the issuing air jet.

The reporters especially stressed the investigations directed toward improving the safety of the preparatory drifts, including the erection of rigid safety strips made of rapidly hardening materials along the working drifts, and the creation of arch supports with a vertical give of 600mm and a horizontal give of 400mm.

S. A. Saratikyants, director of the DonUGI [Donetsk Scientific Research Coal Institute] , described the work of the institute in eliminating the negative effects of a number of natural factors in working on seams at great depths. The plan solutions must provide the following: elimination of the mutual effect between extracting and preparatory work; autonomous work of working stopes with respect to transport and ventilation; the use of efficient methods for preserving and maintaining drifts without repairs; reduce the effect of gas emission from the seams side rocks and associated minerals in longwalls by degassing and liquefying the gas by the isolated feeding of air to the sources of the gas emission; observe optimal stable parameters of the working stope; forecast rock ruptures; continuous transport; minimum number of people at the extracting section; short routes for workers to a fresh air jet in an emergency, etc.

For this purpose, "Recommendations for using arrangements to prepare and finish off extraction fields without leaving coal pillars between longwalls" were prepared and "Promising arrangements for utilizing protective strata at Donbass mines" was written, which regulate the basic aspects for using protective strata. The order of finishing off seams in a formation based on their relative danger of ejections, full protection, condition and prospects of mining development was determined concretely for each mine. Work is being done in the area of the control of mine pressure: initial parameters obtained for creating new designs of

mechanized and individual supports, as well as mechanized KM-103, KD-80 and KPU complexes and coal extracting machines for complicated mining geological conditions. Five-link AP-5 and AKP-5 were developed for drifts in gently sloping seams with a structural vertical pliability of up to 1000 meters.

Jointly with the IGM of the Ukrainian SSR Academy of Sciences, the DonUGI is working on ventilation, gas and heating modes of the mines. The possibility and feasibility of downward ventilation were substantiated, as well as the necessity of increasing the mine depression to 700-800mm of the water column, which reduces the work volume when building a deep mine by 5 to 12 million rubles and the operating costs by 300,000 to 500,000 rubles per year.

In their report, Yu. I. Kalin and M. M. Tyutyunnikov (Pechor NIIproyekt) stressed that 77.8% of the mines at the Vorkutskoye deposit mine at depths of 600 to 820 meters. The average annual rate of depth increase is 20 to 25 meters. The PechorNIIproyekt developed and is introducing technical solutions to localize the effect of complicating factors along two directions:

development of progressive technology for finishing off seams prone to exhibiting dynamic phenomena, arrangements to degas and ventilate extraction sections; development of facilities and methods to control the properties of the rocks in the solid mass for the purpose of weakening them.

In the first direction, progressive solutions were developed and are being widely used in the area of preparation and finishing off coal seams under complicated geological-mining conditions at great depths. They include the following: protective finishing off of seams in the formation; field preparation and making group slope drifts along one seam; simultaneous finishing off of a group of seams within the extraction field; progressive systems of working along the extent and fall of the seam; continuous conveyor coal delivery within the mine wing; progressive arrangements to ventilate the extraction sections and degas the seams and the strata.

The second direction is to increase the efficiency in using mechanized complexes in strata with difficult to collapse roofs at deep levels. For this, methods were developed to reduce the intensity of the manifestations of mining pressures at the moment of the first and second settlings of the basic roof. The creation of an additional network of fissures is the basic idea for weakening rocks in the roof that are difficult to cave in.

G. S. Pen'kovskiy, director of the Dneprogiproshakhta, stated that it is most difficult for designers to determine the parameters of basic deep shafts on whose correct selection depends the efficiency of mine operation. A number of unsolved problems exists. The area of the use of heading machines to extract coal from steep seams, with respect to their thickness and the stability of surrounding rocks, is limited. The problem of extraction from protective seams of substandard thicknesses without people around has not been solved. The changeover to stope machines for operation with electric power instead of pneumatic power is being delayed. There are no powerful explosion-safe locomotives or automatic unloading carts. The rising order of working levels adopted in several projects has serious

shortcomings because, in this case, unprotected zones originate, working conditions deteriorate at the lower levels, etc. The main organization on deep mine problems should be to analyze all their technological links. The solution of the indicated problems will make it possible to increase considerably the technical economic level of the projects and provide further technical progress in the mines of Central Donbass.

V. L. Bozhko (MakNII) [Makeyevka Scientific Research Institute for Work Safety in the Mining Industry] noted that presently there are no highly efficient regional methods for combating sudden ejections of coal and gas. Preliminary degassing of the coal seam and humidifying do not solve the problem fully.

The MakNII scientists set themselves the goal of developing along with designers a series of machines that would reduce the danger of the ejection of the stope part of the coal seam in longwalls and preliminary shafts.

The MakNII developed and introduced the following: arrangements to degas worked-out spaces in steep seams of the Donbass; methods and facilities to combat the contamination of degassing pipelines; a recommendation to determine and provide the rated methane concentration in the degassing pipelines of coal mines.

The following were developed in accordance with the USSR Minugleprom task: a device for the isolated removal of methane emitted while drilling degassing holes, which was introduced in production; additions to PB [Safety rules] in connection with the ignition of methane when drilling degassing holes; a device for measuring gas consumption in pipelines.

In his speech, A. F. Okhrimenko, chief engineer of the "Progress" mine of the "Torezantratsit" Association, stressed that first it was planned to reach the rated capacity of the mine by five longwalls with the continuous system of working, and later changeover to the pillar system of working. When the mine was released for operation after three months, the seam drifts became deformed and the longwalls became inoperable. To this time, at the first settling of the basic roof, a rigid collapse occurs of up to 70% of the support sections of the mechanized complexes in the longwalls. Therefore, in solving the problem on the possibility of using existing complexes at a great depth, it is necessary to establish parameters of a developed system at which they will operate stably.

V. I. Soldatov (Dongiproshakht) touched upon the complex problem of uncovering and preparing sloped fields in deep mines. Efficient solutions are possible, but the engineering work has not yet been done.

Yu. V. Vasil'yev ("Artemugol'" Association) spoke of mines in which steep seams are being worked at a depth of 900 to 1000 meters. Working conditions at these depths became complicated. The most serious problem is working explosion-dangerous seams whose solution would be eased by finishing off protective coal seams of substandard thicknesses (0.2 to 0.4 meters), but there are no facilities for their extraction. In the opinion of the speaker, it is necessary to improve the working of the seams with heading machines; it is necessary to prepare system plans to solve the urgent problems of deep mines and it is necessary to consider the question of creating an experimental level at one of the deep mines.

O. V. Kolokolov (Dnepropetrovsk Mining Institute) [DGI] informed the conference that the DGI investigations on the deep mines problem are being made in the area of uncovering and preparing mine fields, driving and supporting drifts, the technology of drift mining of coal and the control of mine pressures. Thus, for the Central Donbass region, an arrangement of level-block preparation of mine fields was proposed whose development will make it possible to reduce the volume and cost of driving and maintaining drifts, increase the concentration of mining work and improve temperature conditions in extracting and preparatory stopes. This arrangement was developed further by the DonUGI and the Donetsk Polytechnical Institute. Combination supports were developed that operate in combination with the solid mass of rocks. They were used to support over 5km of drifts in deep mines. A mechanized complex is being developed for working seams which are dangerous with respect to sudden ejections of coal and gas without using counterejection measures. The DGI is working on substantiating efficient parameters for the technology of mechanized coal extraction and methods for controlling mine pressures that would make it possible to increase the efficiency and safety of extracting coal from steep and ejection-dangerous seams. Pneumatic chocks were turned over for series production and are being used in mines; work was completed on developing sections of mechanized pneumatic supports. Jointly, with the IGM of the Ukrainian Academy of Sciences, work is being done to develop a machine complex to finish off thin steep seams without people in the working stopes.

F. A. Abramov (IGM Ukrainian SSR) spoke of the necessity of developing physiochemical methods for blocking methane; reducing the aerodynamic resistance coefficient of drifts; improving dispatcher monitoring of mine ventilation; using microbarometers; drilling holes with directed drilling machine tools; developing combines for making drifts in solid rock (with f = 8 to 12); building an experimental mine with a rising order of finishing off levels.

V. L. Grigor'yev (IGD imeni A. A. Skochinskiy) stressed that norm documents developed by the Tsentrogiproshakht, the IGD and other scientific research and planning-design institutes in 1971 and 1972 -- "Basic statutes on developing plans for new mines and modernizing existing coal mines in the Donetsk basin at deep levels" and "Temporary statutes on working coal seams at deep levels of the Vorkutskiy in the Pechorskiy basin," played a positive role in the past Tenth Five-Year Plan period in coordinating planning, constructing, modernizing and operating deep mines, using in practice the basic progressive solutions in all links of the technological processes of coal mining.

They should now be reviewed and supplemented with concepts of new scientific developments and data needed to provide the efficient operation of deep mines.

N. S. Polyakov (Ukrainian SSR Academy of Sciences) noted that extraction from steep seams by heading machines is being used widely; however, this problem must be solved comprehensively by developing machines and devices for all links of the coal mining process. A new kind of hydraulic tank supports for working stopes was developed, and mechanized complexes with high initial support thrust are being developed. The active combatting of dust in deep mines is necessary.

N. M. Sokolov, chief engineer of Mine imeni A. A. Skochinskiy of the "Donetsugol'" Association, reported briefly on working conditions in the mine and stressed the bottlenecks and difficulties. The complicating factors are: working depth -- 1200 to 1350 meters with the consequence of considerable mine pressure and high ambient temperature of rocks and the air in the mine; the presence of complicated geological-mining disclocations and zones with unstable false roofs; great ejection danger of the seam and of sandstones in the soil; high gas content in the seam and surrounding rock; danger of methane emission from fumeroles; a tendency of the seam to spontaneous combustion, especially in cavities of coal and gas ejections; high explosiveness of coal dust and the danger of silicosis in surrounding rock; high water inflow; complicated ventilation system.

During the period of the build-up of the mine, the introduction of new equipment and the assimilation of new technology, close ties were established with the DonUGI, IGD imeni A. A. Skochinskiy, the Ukrainian affiliate of the VNIMI [The All-Union Scientific Research Institute of Mining Geomechanics and Marksheyder Practice], the MakNII, the ShakhtNIUI, the VNIIOMShSom [All-Union Scientific Research Institute of Organization and Mechanization of Mine Construction], the DPI and the MGI. Most of the recommendations of the institutes have been introduced; however, many problems still remain and on their solution depends further success in mine operation.

A. A. Zorin (IGM Ukrainian SSR Academy of Sciences) expressed his opinion that it is possible to cope successfully with mining pressure in deep mines, but further investigations are required to develop efficient facilities and methods to control the solid rock mass. However, the gas condition and the exhibition of mine pressure should not be considered an isolated matter. Penetrating the seam is always related to the dislocation of the heterogeneous medium which, in a number of cases, eliminates the correctness of the forecast and the possibility of monitoring the occurring gas-dynamic phenomena.

The conference of the NTS Section of the USSR Minugleprom adopted a broad resolution defining the program of work for developing coal deposits at great depths and recommended their implementation by scientific research and planning-design institutes and organizations of the Minugleprom and, by coordination with the USSR Academy of Sciences and the Ministry of Higher and Secondary Special Education -- by academic institutes. This is of great national economic importance and will provide technical progress in the basic coal basins of the country.

2291
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FUELS

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LONG RANGE PROSPECTS OF INCREASING COAL MINING IN THE NEAR-MOSCOW REGION BASIN

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[Article by I. A. Kostromin, M. S. Alpatova, engineers (PNIUI [Near-Moscow Region Scientific Research Coal Institute])]

[Text] The basic consumers in the Near-Moscow region coal are the thermal electric power plants of the central regions of the USSR. At present, coal requirements are considerably greater than the existing level of mining and they are met by coal imports from other basins. Due to the scarcity of coal, the Cherepetskaya GRES was changed over to coal imported from the Karaganda basin in 1976. The reduction in the volume of mining was due to the depletion of some mines, as well as a low increase in capacity and long assimilating schedules for assimilating the rated capacity of new mines. Therefore, it is important to prevent further reduction in mining in the following years.

The basic technical directions for improving and developing underground coal mining to the given level are: modernize a number of existing mines that have sufficiently high coal reserves; use the internal reserves of existing mines; build new large mines.

Modernizing mines on a large scale is inadvisable due to the lack of coal reserves in most of the basin's mines. The prognosis for the basin's development by 1980 is the modernization of six mines with an increase of 0.6 million tons in capacity (by replacing the hoisting vessels and machines, expanding shafts and other drifts).

The possibilities of increasing the production capacities of existing mines by using internal reserves are extremely limited: over 75% of the mines have a loading which exceeds 1.2 to 1.5 times their rated capacity. Adding reserves to the existing mines can be done only in four mine fields due to the lack of reserve sections in the mine strata.

In 1980, the basin will have 42 operative mines (administrative units) with a total annual capacity of about 22 million tons. The introduction of two new mines cannot make up for mining losses due to the depletion of many sections in the coal fields.

One of the reserves for maintaining the coal mining level and increasing the service life of the mines is the development of reserve mine fields written off for various reasons. The PNIUI, along with the IOTT [expansion unknown] did wor' to determine the possibility of putting in operation reserves in mines whose finishing-off was planned after 1980. The technical documentation of 15 mines of the "Novomoskovskugol'" Association and 12 mines of the "Tulaugol'" Association was studied. An analysis was made of the number of sectors with balance reserves, written off or due to be written off because of the unprofitability of their development, unworkable seam thickness, high ash content of the coal and complex mining-geological and hydrogeological conditions.

Table 1

No. of mines	Volumes of coal reserves written off or due to be written off for reasons, thousands of tons					Total
	unworkable thickness (less than 1.3m)	high ash content (over 40%)	unprofitable to finish-off	complex mining-geological conditions	other	
27	11,637.2	2,359.8	4,469.1	837.8	8,494.4	27,785.3
in %	41.9	8.5	16.0	3.0	30.6	100.0

Table 2

Mine	Extracting	Preliminary	Drying	Total
"Lyutoricheskaya"	3.26	1.20	0.22	4.68
"Sokolovskaya"	1.95	1.23	0.22	3.40
"Pokrovskaya"	1.61	0.40	0.22	2.23
"Borodinskaya"	1.95	1.09	0.22	3.26

Of the total volume of written off or due to be written off coal reserves, 27,785,300 tons or 59.5% are beyond the boundaries for mining; 40.5% of the reserves are accessible from existing drifts and for finishing off. Actually, the written-off reserves are 18,183,700 million tons or 65.5% with 14.5% of them accessible for mining and 51% not accessible. Reserves due to be written off are 9,601,600 tons (34.5%), of which 7,233,100 tons (26%) are accessible and 2,368,500 tons (8.5%) are beyond the mining zone.

Table 1 shows the distribution of volumes of reserves written off or due to be written off for various reasons.

The basic part of the reserves of 11,637,200 tons (42%) are concentrated in seams less than 1.3m thick and are located in marginal zones of the mine fields. In second place by volume -- 8,494,400 tons (30.6%) are reserves written off for other reasons (due to the unworkable thickness of the seam, high ash content, complexity of mining-geological conditions, etc.).

To establish the volume of preparation necessary to reach the reserves, their distances and the work to finish them off were determined from mining plans. It was established that reserve sectors written off or due to be written off are located at various distances of 60 to 1800m from the active drifts with reserves in each sector from 4200 to 1,425,000 tons. Thus, each coal reserve sector has varying volumes and distances from the active mining zone.

To assess the possibility of extracting this coal, an economic study was made on the feasibility of working these reserves by comprehensively-mechanized longwalls as is done in the mines of basins that have different mining and hydrogeological conditions ("Lyutoricheskaya," "Sokolovskaya," "Pokrovskaya" and "Borodinskaya"), with an obligatory enrichment of this coal at an inexpensive (170,000 rubles) enriching installation (steep-slope separator KNS).

In calculating the cost of extracting one ton of coal of substandard seams, additional costs for their preparation and finishing off were assumed as the sum of the costs of face breakage, digging and drying shafts according to items "wages," "materials" and "amortization." Sectors in all mines with written-off reserves are subject to more flooding, more complex hypsometry and considerable squeezing of the coal. This means paying higher wages at the planned sectors as compared to those at existing mines. The amortization deductions per ton of mined coal is considerably higher than in existing mines due mainly to lower loading at the longwall.

Additional costs per ton of mined coal (in rubles) for four mines are shown in Table 2.

Since the ratio of coal mining is written-off sectors will be 20% of the total mining, the effect of the additional costs on the increase in production costs of all mines will be considerably smaller; from 0.31 rubles for the "Sokolovskaya" mine to 1.01 rubles for the "Lyutoricheskaya" mine. Taking into account the higher ash content in the written-off sectors (over 40%), the wholesale price of the coal will be lower than that of the actual one.

The technical-economic calculation of the feasibility of extracting and enriching the reserves of substandard seams for four mines indicated that the expected production cost of a ton of enriched coal will be 3.21 to 5.40 rubles.

The national economic effect of using a ton of local coal instead of imported coal (as applied to the Cherepetskaya GRES) will be 2.76 rubles of natural fuel, mined from written-off sectors of coal reserves that had lost their production value.

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ROLE OF COAL QUALITY IN PLANNING, PRICE-SETTING

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[Article by S. S. Fedorov, candidate of technical sciences (TsNIEIugol') [Central Scientific Research Institute of Economics and Scientific Technological Data in the Coal Industry]]

[Text] At present, setting quality norms for coal products of the coal industry is done according to existing instructions. To eliminate their shortcomings, a new method was developed for calculating the quality norms of coal. However, it also has shortcomings as in the existing instructions. In particular, the proposed order for calculating the value of coal contamination by surrounding rocks does not reflect the specifics of strip mining.

This shortcoming may be eliminated within the framework of the procedure adopted for developing quality norm indicators. But there are aspects that require radical reinterpretation. This applies to the evaluation of the relationship between the functions of setting quality norms indicators for coal products and planning. The following should be noted in this connection.

From the compared analysis of the accepted order of work on substantiating quality indicators in specifications (TU) and in annual planning it follows that the following kinds of work are identical in form and content: preparation of initial data, observance of requirements for the preparation of project plans and the evaluation of the quality of sampling seams. With respect to direct work on substantiating quality indicators, it should be noted that quality norms set in accordance with specifications in the first year they are in effect are, at the same time, also the planned quality indicators. It follows from this that the procedures for setting the norms and planning (in the year that the specification were prepared) coincide fully. This provides a basis for assuming that quality indicators of coal products, substantiated when preparing the plan, must serve as an average norm accepted for implementation. This transposition of accents does not change the essence of the procedure for developing quality indicator norms; however, it makes it possible to determine more clearly the position of setting norms in the system of planning accounting.

The principle itself of setting specification norms in accordance with the results of plan accounting cannot be objectionable, but norms established in planning for the preceding period cannot be used to substantiate plans in future years. Therefore, the practice in industry of reconsidering the values of the quality indicators, due to a change in natural conditions when computing plans and in specifications (temporary norms), should be acknowledged as correct. This makes it possible to control production effectively but places it unwittingly in a difficult economic situation. In shipping coal at stable wholesale prices established on the basis of quality indicators at some previous date, enterprises, due to the variability in natural conditions, are forced to ship coal in the planned order at lower prices (if it is considered that higher ash content of mined coal is a prevailing trend). Naturally, the sales volumes is reduced, profit is lowered and deductions to the enterprise funds are decreased.

Therefore, one of the main shortcomings of the existing system of plan accounts is the lack of measures to compensate for the reduction in prices. It occurs as a result of the gap between the values of quality indicators, corrected in current planning and reconsideration of the specifications, and their values that were effective in the year preceding the introduction of the price list, as well as due to change in the cost of coal production by the effect of technical-mining factors. To eliminate this shortcoming, it is proposed to set wholesale prices according to average production costs for a certain kind of product by taking into account the provision of normal cost accounting conditions for the functioning of enterprises, associations and the industry in the first year of the plan period. In the following years of a given period, in compensation for loss, due to the negative effect of natural conditions on economic activity, it is proposed to introduce a system of external graduated accounting prices. They are decided on the basis of plan wholesale prices (they can differ from actual ones) determined each year, taking into account changes in production costs, quality and the structure of mining, with additional payments from a stabilization fund, substantiated in the process of plan accounting, in amounts that cover the loss due to changes in natural conditions.

Thus, products will be shipped to consumers during the period that the wholesale price list is in effect according to stable wholesale prices, while the enterprises and associations will be paid according to external graduated accounting prices that exceed wholesale prices by the value of the loss that would have been unavoidable, if the coal delivery was made according to stable wholesale prices.

The term "external graduated accounting prices" has a somewhat different meaning than the term "graduated account prices" well known in mining economic literature. When the latter were established, basic attention was given to achieving an equal sum from sales according to wholesale and accounting prices. The volume of sales according to external graduated prices will differ from the volume of sales according to plan wholesale prices by the value of the loss (profit), due to changes in production cost, product quality and structure of mining beyond the first year of the plan period, and could not have been compensated for by the redistribution of the accumulated money within the association with the established price list. The indicated value of the loss must be covered in the planned order from a centralized norm stabilization fund.

The value of that part of the norm stabilizing fund which is related to the effect of changes in the quality and structure of mining coal is calculated as follows:

During the entire five-year plan period, coal deliveries were made according to quality norm indicators established for each year, but not exceeding the values of GOST for various kinds of consumption. The size of deductions from the norm stabilization fund (or its supplement) for the formation of the external graduated accounting prices was determined as the difference between the sale price, determined according to planned wholesale prices of the enterprise in the considered year, and the sale price of the product of the same year, but determined according to planned wholesale prices of the enterprise in the first year of the planned period. If the indicated difference has a plus sign, it means that finishing off conditions in the considered year were more favorable as compared to the base period as a result of which the enterprise has a surplus not related to the results of the economic activity of the enterprise itself. This surplus must be transferred to the norm stabilization fund. If the indicated difference has a minus sign, it means that the finishing off conditions changed for the worse. The enterprise has a loss not due to a reduction in the efficiency of its economic activity and, therefore, it should be reimbursed from the norm stabilization fund by the external graduated accounting prices. The plan value of the norm stabilization fund of an enterprise in the five-year plan period is determined by the algebraic summation of the accounting results by years. If the result has a minus sign, the enterprise must be compensated by the indicated sum for the loss due to the deterioration of natural conditions. And, conversely, if the result has a plus sign, the obtained sum must be repaid to the norm stabilizing fund of the next higher level of planning.

At the next level, taking into account the results of plan substantiations of enterprises (production units) and structural changes in mining for the association as a whole, a plan is formed for the association norm stabilizing fund. In its turn, the USSR Ministry of the Coal Industry prepares the plan for its norm stabilization fund by using a procedure similar to that for associations.

It should be noted that if the enterprise, in the process of fulfillment of the annual plan, achieves an improvement in the coal production by technical, technological or other measures, the additional product should be redistributed between the government and the enterprise. If the enterprise does not fulfill its plan task on quality, a loss originates which should be reflected in the results of its financial activity.

The cited method for accounting for the dynamic production cost, quality of the coal and the structure of mining in price setting is inseparable from further improvement of the entire procedure of plan accounting.

Practice has proven that accounting for the quality in planning as an auxiliary indicator is not capable of providing optimal solutions.

A characteristic example of using quality indicators in optimization models is an expression of restriction of the kind

$$\frac{\sum_{i \in I}\sum_{j \in J} r^{\alpha}_{ijt}\, d^{\alpha}_{ijt}\, x_{ij}}{\sum_{i \in I}\sum_{j \in J} d^{\alpha}_{ijt}\, x_{ijt}} \leq R^{\alpha}_{t} \; (t \in 0,\ \alpha \in A),$$

where $r^{\alpha}_{ijt}, d^{\alpha}_{ijt}$ are respectively ash content and coal extraction of the α brand in the t year at an i enterprise, operating in the j version:

$$(i \in I,\ j \in J,\ \alpha \in A)$$

x_{ij} $\begin{cases} \text{1, if the j version is adopted at the i enterprise in the} \\ \text{optimal plan; 0 -- in the opposite case} \end{cases}$

$$(i \in I,\ j \in J);$$

The right part of the cited restriction, interpreted as "the established norm of ash content," is a calculated norm of ash content for a group of seams combined into one output, which itself must be reconsidered when the participation of the seams in the mining and ash content norms of the seams are changed. As has been shown, in analyzing the adopted order of work on substantiating quality indicators in the specifications and with annual planning, the current planning and substantiation of specification norms -- is the same kind of work for the first year the specifications are in effect. Therefore, the specification norms must be established on the basis of optimizing the accounting of the annual plan that coincides with the calendar year in which the specification was put into effect. Thus, an attempt is being made to optimize the production plan on the basis of the quality indicator norms in the specifications, while the latter are themselves a reflection of the results of the optimal plan. In other words, using "the established norm of ash content" indicator as a restriction is in essence an attempt to substantiate plan solutions by proofs which themselves require proof.

This confirms the position that to solve the problem of optimal planning it is necessary to consider the quantitative and qualitative sides of production in their dialectic unity. The use of coal products quality indicators as auxiliary ones in the total procedure of plan substantiation cannot solve the problem of optimizing planning in this industrial sector.

In our opinion, plan accounting should represent a search for the optimal structure of production capacities that must be carried out in the process of realizing and intercoupling local models of optimal planning.

By the structure of the production capacity of an open pit (mine), we mean the ratio of coal volumes that make up this capacity, extracted from different blocks (sections) and differing in their consumer value.

By the structure of production capacity of an association, we mean the ratio of commercial product volumes that make up this capacity, differing in their consumer value, produced by enterprises (production units) that are within the association.

By the structure of production capacity of the industrial sector, we mean the ratio of volumes that make up this capacity, differing in their consumer value, produced by production associations that are within the industrial sector.

The nonlinearity between the costs and the level of quantitative and qualitative indicators of coal extraction made it necessary to develop a special heuristic algorithm for the solution of the optimal planning problem.

At the first stage of potentially-optimal plan is being developed for each individually considered enterprise according to a maximum average-weighted profit criterion while observing resource limitations. Then, the enterprises are arranged in the order of diminishing values of average-weighted profits obtained in local optimization. Further, the plan volumes of commercial coal are redistributed taking into account deliveries according to the kinds of consumption from the worst (with respect to the level of the average-weighted profits computed in the previous stage) to the best enterprise.

The economic meaning of each iteration consists of providing for an increase in the average-weighted profit of an association. With such a redistribution, the resources of the best enterprise expand automatically at the expense of the worst ones, remaining within the framework of the total resource limitations for the association.

After each act of redistribution of the volume of commercial products between two enterprises the values of the average-weighted profits, characterizing their activity, will change. Therefore, before each new iteration, the arrangement of enterprises according to the value of their average-weighted profits will be repeated. The cited method was realized on the "Minsk-22" computer for strip mining steep seams in Central Kuzbass.

The cited version of combining the functions of planning and setting prices must be tied to the general procedure for developing different kinds of plans and stages of the planning process.

For this purpose, taking into account the modern state of planning in an industrial sector and the prospects of its improvement in the light of the decree of the CPSU Central Committee and the USSR Council of Ministers "On improving planning and strengthening the effect of the economic mechanism on increasing the efficiency of production and quality of work," a logic circuit was proposed for developing plans, the presentation of which is beyond the framework of this article.

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ON IMPROVING PIPELINE TRANSPORT

Moscow UGOL' in Russian No 11, 1980 p 63

[V. F. Krylov and B. Ya. Ekber (USSR Ministry of Coal Industry) review of book by A. Ye. Smoldyrev: "Pipeline Transport." Third edition rewritten and supplemented. Moscow, Nedra, 1980, 294 pages]

[Text] Hydraulic and pneumatic transportation of coal, rocks, filling and other friable materials over pipelines has considerable prospects for further development. Moreover, it is necessary to increase further the efficiency of mine technological systems of pipeline transport which, in each concrete case, is determined, besides application conditions, by scientifically substantiated parameters, the type of the basic equipment and the quality of manufacture of the equipment. Therefore, engineering solutions used in various technological arrangements of pipeline transport, as well as parameter calculations, must be based on modern scientific pipeline transport that provides the theory and methodology for computing hydraulic and pneumatic systems to transport coal, rock and other friable materials through pipelines. These problems are covered in the book being reviewed. This book was extensively rewritten and updated with new materials obtained by the author and other investigators.

The advantage of the book is that it cites widely the conditions for using hydraulic and pneumatic transport (a system of transporting over long distances, within enterprises or various technological links of production). Experimental data is presented on the motion processes of hydraulic and air mixtures in pipes, and the technical characteristics of pipelines and power equipment. Of importance is the fact that the basic problems of computing the parameters of hydraulic and pneumatic transport were solved by a single method.

As compared to the second edition, the book is supplemented with new, valuable experimental materials. It cites profiles of the velocity and concentration of mixtures distributions in pipes, as well as data on pressure losses and critical velocities when moving coal and rock in pipes of hydraulic and, especially, pneumatic transport installations. It also gives extensive measurements for air-lift systems, arrangements of experimental installations built, etc.

The most essential results of the investigations and the experience of application, obtained at domestic and foreigh enterprises, are systematized and this makes the book especially useful to designers.

Yet, the book has some shortcomings. Thus, the process is not sufficiently clear about the motion of coal-rock hydraulic mixtures when determining the profile distribution in the cross section, pressure losses and critical velocities in the pipes. In computing the parameters of transporting coal mixtures with high concentrations, the effect of the type of coals, for example, lignite from the Kansko-Achinsk basin, on the transport parameters was not reflected. The transport distance was not given in calculating the relationships in the pneumatic transport. There are aggravating errata and certain inaccuracies. However, the noted shortcomings, in our opinion, do not detract, as a whole, from the high professional standard of the presentation of the scientific bases of hydraulic and pneumatic pipeline transport. The publishing of this book will have a significant effect on the development of equipment and the technology of hydraulic mining and mine transport.

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PROBLEMS OF WELL REPAIR, EFFICIENCY DISCUSSED

Novosibirsk EKONOMIKA I ORGANIZATSIYA PROMYSHLENNOGO PROIZVODSTVA in Russian No 10, Oct 80 pp 73-78

[Article by N. Kh. Khamidullin, deputy general director for economic affairs of the Tatar ASSR Petroleum Association, and M. K. Giniatullin, chief economist of the Dzhalil' Petroleum Administration, Al'met'yevsk: "The Oil Well and How Well It Works"]

[Text] The modern oil well is a complicated and expensive extraction engineering structure. In any petroleum extraction association wells account for roughly half of the value of all fixed productive capital. Moreover, petroleum extraction is the most capital-intensive (and also metal-intensive) sector of industry. Depreciation deductions are more than one-third of direct expenditures for petroleum extraction.

It is common knowledge that well downtime leads to significant losses of petroleum. Downtime of one percent of the wells in the sector is equivalent to taking one large deposit from the country's fuel-energy balance. Increasing the period of well operation between repairs is one of the main conditions for raising labor productivity in the petroleum industry as a whole. That is why reducing oil well downtime is viewed as an important national economic problem.

What Is Being Done on This Problem Today?

Work to improve current well downtime can be done in two directions. In the first place, it is possible to continue building up the capacities of the current (underground) repair service for wells and associated facilities. In the second place, it is possible to improve the design of wells and raise the quality of equipment manufacture and use, which permits an increase in the period of well operation between repairs.

The most efficient (and at first glance simple) solution to the problem is increasing the number of current well repair brigades as the need for current repair grows. The more such brigades there are, the fewer wells will be down.

Early in the development of the large petroleum extraction regions of the Ural and Volga area this extensive way to solve the problem was the only one and was probably justified. But in recent years the number of repair services has

increased faster and faster in connection with qualitative changes in the wells and conditions of their use.

Thus, in the last 10 years the flooding of output at the Tatneft' [Tatar ASSR Petroleum] Association has risen from 27 to 62 percent. In this same time the mechanized method of extraction has also completely supplanted the simpler and less expensive flowing-well method (its proportion has declined from 29 percent in 1970 to 2.2 percent in 1978). Under these conditions the number of repair jobs per operating well increased by 21 percent. Nonetheless, during these years the period of well operation between repairs increased by almost 35 percent and the growth in the capacities of underground well repair services is even somewhat greater than the growth in number of wells. All the same, these capacities are not insuring normal well operation. Well downtime waiting for repair is being reduced, but slowly. In 1978 the downtime figure was 105.4 hours per well compared to 160 in 1970; at the same time the length of the repair job itself was 42 hours.

The time a well spends in underground repair, including time between shifts, is 62.7 hours. In 1978 this downtime cost 2,860 machine-months, which is equivalent to 240 wells standing idle for the entire year.

In neighboring petroleum extraction regions the specific number of underground well repair brigades per operating well is at about the same level or even higher. The same thing can be said for labor productivity (see table below).

Table. Indicators of Underground Well Repair by Associations.

Association	Specific Number of Underground Well Repair Brigades per Well	Number of Repair Jobs per Brigade Employee
Tatnetft'	0.10	18.4
Bashneft' [Bashkirskaya ASSR Petroleum]	0.09	17.2
Kuybyshevneft' [Kubyshev Petroleum]	0.10	17.2
Perm'neft' [Perm' Petroleum]	0.27	6.5
Orenburgneft' [Orenburg Petroleum]	0.17	13.8

The design organizations and manufacturing plants continue to be greatly in debt to petroleum workers. New equipment and means of mechanization for underground repair are being developed and incorporated in series production very slowly by industry.

Thus, despite the fact that the period of well operation between repair jobs has increased and the number of repairs per tour of duty has risen 17 percent in the last decade, well downtime waiting for and during repair itself is being reduced slowly.

What Does Ongoing Well Repair Cost and What Awaits Us in the Near Future?

In 1970 about 11 percent of industrial production personnel at the Tatneft' Association were employed in current repair of wells or deep pumping equipment

for the wells; today this indicator is already 18 percent. The number of such workers has risen almost 50 percent in the last five years.

Production associations incur substantial material and financial expenditures for current well repair. At Tatneft' in 1978 these expenditures were 21.6 million rubles. Current repair of wells and pumping equipment draws off about 10-12 percent of all industrial transportation, special equipment, and duty vehicles in the service of petroleum extraction administrations and more than 20 percent of the personnel of transportation subdivisions.

In 1990 the number of producing wells at Tatneft' will rise to roughly 20,500 units, and about 85 percent of them will be slant wells. Practically all wells will be exploited by the mechanical method. The proportion of high-sulphur petroleum in total extraction will increase. It is expected that as the wells age and the technology of petroleum extraction becomes increasingly complex (even if the rate of increase in the period between repair jobs is maintained) the number of current well repair services will increase 60-70 percent.

Serious difficulties will arise in staffing these services, despite the relatively high wages. As a result of the low level of mechanization and different working conditions, ongoing well repair remains one of the most labor-intensive and least attractive jobs in petroleum extraction. Moreover, reducing specific labor inputs per well is now one of the main indicators of efficiency in petroleum extraction and one of the two fund-formation indicators. At the Tatneft' Association, for example, the number of industrial production personnel by 1990 is planned to be just eight percent more than in 1978, which is an average annual growth rate of 0.7 percent. Therefore, numerical growth of the current well repair service can be achieved only at the expense of other jobs at the petroleum and gas extraction enterprise. This is not always possible or justified.

The Answer Is To Organize a Comprehensive Control System

A comprehensive program to sharply increase the period of operation of deep oilfield equipment between repairs and, on this basis, to reduce the need for current repair should become the general line of activity in increasing the work capacity of the wells and reducing downtime.

The role played by the period of well operation between repairs is well-known. It determines both the number of repair services and the need for equipment, production capacities, and, ultimately, the reliability of operation of the entire system. Increasing the period between repair jobs is above all a problem of quality. The reliability and durability of any machine, of any technological structure, are determined by its design, quality of materials, and operating conditions. If we are speaking of an oil well, its work capability depends largely on natural conditions as well. The ways to increase the period of operation between repair jobs involve a favorable combination of all these factors.

Many services and production collectives participate in preparing the wells for operation and supporting its work during the petroleum extraction process. Among them are geologists and construction workers, drilling workers and geophysicists, the repair services, material-technical supply organizations,

transportation workers, and finally production engineers specializing in petroleum extraction. The reliability of well operations and their periods of operation between repairs depend on how well all the elements of this complex production system work together and how their interaction is organized.

Many problems must be solved to establish an effective system to control the quality of well operations. Organizing a system for monitoring and recording the quality of labor is especially difficult. At the present time only the quality of the final product, petroleum, is monitored and encouraged. The times demand the formulation of a unified system of technical monitoring for all the most important industrial operations and processes.

Many associations are following the example of other sectors and trying to use a coefficient of labor quality to evaluate the quality of labor and provide material incentive for it. But there are difficulties here having to do with the specific characteristics of the sector. We are dealing with natural factors whose impact is not always subject to prediction and record-keeping.

In our opinion, the most promising and timely challenge is to formulate a unified system for control of the quality of well operations at the sector level. It is at this level that the primary directions of development of technical progress in the petroleum industry are defined. It is the sector that decides questions such as centralization of the delivery of equipment and materials to associations, concentration and specialization of repair work, and the production of particular types of equipment. The uniform norm system is established at the sector level. But at the same time, the problem of reducing well downtime is not completely soluble by the sector alone.

The Period of Well Operation Between Repairs Is an Intersectorial Problem

The period of well operation between repairs synthesizes the work of many economic sectors. The principal factor that holds back growth in this period is the inadequate quality of the equipment and materials delivered to petroleum workers. In Tataria three-fourths of all petroleum is extracted using expensive deep-well electric pumping units that are complex in design and labor-intensive to operate. In 1978 9.7 percent of this equipment delivered to the oilfields of Tataria had factory defects. But this equipment is put into the wells. Under the conditions of the Tatar ASSR oil fields this means that an electrical pump unit 15-20 meters long weighing approximately one ton is lowered to a depth of 1.5 kilometers. The cable that feeds the submersible electric motor weighs several tons, and there are also the pump-compressor pipes. This entire complex system works while suspended, pumping petroleum from the well face to the surface without stopping. To replace or repair a defective unit the well must be shut down for 2-3 days and the entire aggregate with cable and pipes brought to the surface. All this equipment must be replaced or repaired and then again lowered to the same depth. Well downtime leads to incomplete petroleum recovery. The entire underground repair job takes place in the open air, at any season, which means under exceptionally unfavorable conditions for the workers.

In order to prevent premature repair of wells in some degree petroleum workers are forced to inspect new equipment a second time after factory testing. Workers from other jobs, additional material resources, and production areas are taken away for this purpose.

But factory defects are just one of the causes of wells going into repair ahead of time. We are talking about substantially increasing the longevity of all equipment, approximating it to the best existing models. The electric motors and hydro protection of deep-well electric pumps do not have adequate reliability. More than half of the repair jobs are the fault of these units. Raising the quality of electric centrifuges to the level of the best models and applying new high-strength materials would make it possible to double the period between well repairs, eliminate well downtime waiting for repair, and substantially reduce current repair capacities.

Out of Order

But it is not just a matter of improving certain parts or assemblies. A full assortment of highly reliable and durable equipment must be developed for operating wells under the most diverse conditions. This is a major scientific-technical problem whose solution requires a multilevel, intrasectorial program of national scope.

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EXTRACTION PLANS THWARTED BY POOR PLANNING AT VAR'YOGAN

Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian 13 Nov 80 p 2

[Article by Yu. Belanov, Tyumen', Nizhnevartovsk, Raduzhnyy: "The Difficult Oil of Var'yogan"]

[Text] Alarming reports from the Var'yoganneft' Petroleum Extraction Administration began arriving at Glavtyumenneftagaz [Main Tyumen' Production Administration for Petroleum and Gas Extraction] as early as last spring. In April they extracted 36,000 tons of petroleum less than the monthly plan, and in May they were 93,000 tons short. In July the situation stabilized somewhat and there was a hope that the oil field workers would somehow manage to make up the lag. But the reports for the second half of the year again showed "minuses." In August the deviation from the plan was 157,000 tons of petroleum, and in September 179,000 tons. By now the total indebtedness of the Var'yogan workers since the start of the year has reached 500,000 tons of this fuel that the country needs so much.

How could such a thing happen?

The MI-6 had scarcely taxied in to the landing area when the crowd of people hungering to go to the community of Raduzhnyy raced toward the open hatch of the helicopter. Strong shoulders squeezed me and picked me up like a blade of grass. I was carried towards the helicopter where the ship commander, in a hoarse voice, read off the names of the 58 lucky ones.

Every duty helicopter at the Nizhnevartovsk heliport is assaulted in this way. And it is no surprise, because this is the only way to get to Var'yogan.

At my first meeting when I asked the workers where they thought the losses of petroleum began someone in the crowd answered in a perfectly serious voice, "At the housing office."

I followed their advice and visited the housing and municipal services division of the Var'yoganneft' Petroleum-Gas Extraction Administration. The bare figures on domestic conditions revealed a great deal.

At the present time 4,000 people are making their homes in overpopulated, poorly furnished dormitories whose basic furniture is nothing but double bunks.

The bakery and bath and laundry combine need repair urgently. The school does not have enough teachers and works on three shifts. A tiny little unheated room has been assigned for the post office. The supply of food products, especially vegetables, to the worker community is not satisfactorily organized.

Of course, the shortage of clean sheets and fresh cabbage is not the only reason that petroleum extraction plans are systematically violated. But poor living conditions lead to worker mobility, which has reached a critical point in the administration. In the first nine months of this year 452 people were hired and 533 were discharged. Mobility among workers was 52 percent and among engineering-technical personnel it was 60 percent. And those leaving Raduzhnyy are for the most part not "short-timers"; they are working people who cannot get accustomed to the harsh conditions of this northern region.

In the opinion of I. Rynkovskiy, acting chief of Var'yoganneft', chief engineer A. Petrov, and other managers of the administration with whom I talked, it was no accident that systematic failure to fulfill plans for petroleum extraction began in April. It was precisely at this time (or more accurately in March of 1980) that Var'yoganneft' was moved from the city of Nizhnevartovsk to the community of Raduzhnyy.

On the face of it such a decision, to move the management apparatus of the administration, its technical services, and supply bases directly to the region of the deposits being exploited, raises no doubts. It is a difficult matter to guide and monitor the work of production brigades from Nizhnevartovsk, separated from the fields by the impenetratable, swampy taiga.

What is hard to understand, however, is the haste and ease with which this step was taken by L. Vyazovtsev, general director of the Nizhnevartovskneftegaz [Nizhnevartovsk Petroleum Gas] Production Association and the managers of Glavtyumenneftgaz. It was certainly obvious then, in the spring, that there would be no road to Var'yogan in the near future. And Raduzhnyy itself, which only recently received the status of worker community, was completely unprepared to receive the newcomers.

The results of this ill-conceived decision were not long in showing. The administration immediately lost 70 percent of its most experienced specialists who had worked in the north from three to nine years. People did not want to part with their families, for whom there was no place in the worker community. Could they be blamed for this?

The supply problem became much more complex. Whereas before a specific supply subdivision in Nizhnevartovsk which was supplied with all essentials had been responsible for supplying the petroleum workers, it is now considered that it has its own base in Raduzhnyy. It has an impressive name: base for production-technical supply and full sets of equipment. But one can hardly take this seriously upon realizing that it refers to an open-air, unfenced area on the bank of the Agan River where there are neither docks nor warehouses.

"You see how we are forced to store machinery and materials," Ye. Buzik, chief of the section of loading and unloading work, said.

Then he pointed to the cement that had turned into stone piles, and the rusted and partly dismantled equipment for petroleum preparation units. The drilling workers experience a constant and critical need for pump-compressor pipe and turbodrills. The brigades employed in building at the deposit spend hours idle because of shortages of necessary equipment, materials, and machinery.

"Before we at least had hope for Nizhnevartovsk," they told me bitterly, "but now you cannot get anything there or at our base."

In such a situation one would expect the managers of the association to make all possible organizational efforts to somehow straighten out the consequences of their own mistakes and miscalculations. But instead of giving this suffering collective concrete, business-like help they have taken a different way.

In September the Nizhnevartovskneftegaz Association assigned the Var'yogan petroleum workers to extract 1,190,000 tons of fuel in a month. The administration assessed its potential and came to the conclusion that in the existing situation it was not feasible. They wrote up a program to extract only 1,037,000 tons of petroleum in September. The associations rejected these measures and demanded strict fulfillment of its directive.

Okay, the Var'yogan workers said. But such an amount of fuel could only be extracted on the condition that 49 wells were switched to mechanized extraction, which required the formation of nine additional underground repair brigades. The new alternative was included in the association's summary plan and sent to the main administration, although they knew in advance that it would be impossible to provide the personnel and material resources necessary to perform the assignment.

What was the result? In September just one of the 49 wells which on paper were to be converted to mechanical extraction was in fact converted. As a result of this they were more than 55,000 tons short of the plan. Moreover, the plan for introducing producing and injection wells was not fulfilled, which led to an additional 70,000 tons of fuel short of the plan.

The party committee of the association, headed by V. Romanenko, is surprising. This was an exceptional situation, but the party did not even meet to discuss the question of the failure of the Var'yogan workers to fulfill the state program. Neither did the Nizhnevartovsk city committee of the party.

But the communists of Raduzhnyy need help very badly. The community has about 40 subdivisions of petroleum extraction, drilling, and construction workers and geologists. They are performing an important state mission, but their party organizations are not working together. For example, they could make use of the know-how of their neighbors in Omich and form a council of secretaries with the rights of a party committee. This would be especially useful because the Var'yogan petroleum workers and their many associated workers have made numerous miscalculations and omissions and have many unused internal reserves.

They were discussed frankly, with managerial concern, by communists V. Morev, A. Chkanikov, A. Volkov, and I. Kruglyakov, from petroleum and gas extraction shop No 2, at a recent party meeting on the results of the third quarter.

"It hurts to see such a thing," V. Yalovets, booster pumping plant operator, told me, pointing to an enormous flare from which black smoke curled upward. "More than 300 tons of petroleum is burned off at the Var'yogan deposit together with by-product gas every day because we do not have adequate refining capacities."

A great deal of petroleum is lost as the result of organizational and technical problems at the booster pumping plants, petroleum-gas separators, and other "hot spots" of shop No 1, the largest in the administration.

"Var'yogan is a bitter lesson to us all, a sad example of the fact that it is not possible to get such volumes of extraction at an unprepared deposit. This is an advance party of the oil industry, cut off from its rear areas," L. Vyazovtsev, general director of the Nizhnevartovskneftegaz Production Association, acknowledged.

Concerning the lesson to be learned he is exactly right. What is unfortunate, however, is that so far neither Nizhnevartovsk itself nor Glavtyumenneftegaz, nor the Ministry of Petroleum Industry, has drawn the proper conclusions.

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